Software development performance in remote student teams in international computer science collaboration

Thesis

UNRESTRICTED.

Software Development Performance in Remote Student Teams in International Computer Science Collaboration

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Abstract

Approximately two-thirds of software projects are late because project teams encounter challenges that threaten their success. In addition, many projects are developed using remote collaboration, due to pressure of time, distribution of expertise, and organisational constraints. In parallel, technology has developed that allows effective remote collaboration.

The purpose of this research was to investigate what characterises high performance in software development in remote student teams. The data was drawn from the Runestone Project, which involved Swedish and American computer science students in international collaboration on a substantial software development project. Runestone gave students the opportunity to use different technologies for collaboration across time and distance, as well the chance to develop problem-solving experience with different cultures in a team-based environment.

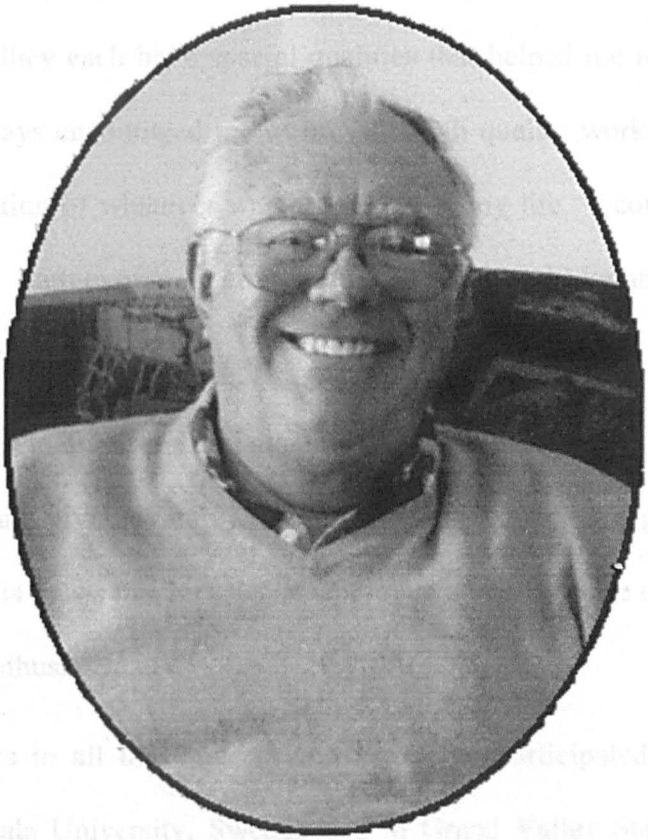
This research tracked the progress and changes in the entire electronic communication for 8 student teams identified as the 4 highest- and lowest- 4 performers in the 2000 presentation of Runestone. A set of categories was developed to characterise over 31,000 lines of communication, focusing on the amount and nature of communication for each team, and on decision-making patterns throughout the software development process. The research also looked at students' use of available communication technology.

Results indicate that both communication and the process and timing of specific actions are crucial to a team's success. Teams communicated differently, with high performing groups communicating less. High performing teams were more organised in the way they conducted their meetings and work. The management of the software development process as a whole was crucial, as was leadership style. An effective use of the software development process can also mean that key decisions are made during the times in the

software process where they will be most effective. This research has implications for remote collaboration in both education and industry.

This Thesis is dedicated in loving memory of my father-in-law,

Clyde I. Hause.



My father-in-law had a strong and vibrant personality with which he shared his joy of life with everyone he met. Anyone who knew him, couldn't help but be drawn in or influenced by his enthusiasm.

The influence my father-in-law had on my life came more from his gentle spirit. His gentle and quiet way when he read my abstract and shared his ideas with me. His gentle and mischievous way in which he teased me about when I would finish my thesis so he could book his flight for my graduation ceremony. And most of all, his gentleness when he gave me a pat on the back and a look of belief and pride in me.

His memory will live on in my heart and will continue to influence me for the rest of my life. I am grateful to have known my father-in-law, Clyde I. Hause.

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Chapter 1

Introduction

1.1. Aim of Thesis

The aim of this study and therefore this thesis was to investigate how student teams[1] build software at a distance and what characterises high performance in terms of software development in remote student teams in Computer Science.

There has been a great deal of research carried out on the development, performance, activities and composition of teams. Previous research on teamwork however, has been limited to experimental situations where a face-to-face team is given a non-specific short-term task. This thesis was concerned with remote teams working across time zones on a specific software development task. It dealt with issues such as teamwork in terms of roles and structure, decision-making, software development process and the communication technology used. The investigation looked at the communication via a set of categories developed and validated for this study. The emphasis of the analysis was on the characteristics of team performance.

---

[1] **Team or Group** – a combination of individual members working together towards a common goal. For example, team H1, team L1 and team H2. The term 'team' or 'group' will be used interchangeably throughout this thesis.

1.2. Motivation for the Thesis

The rapid improvement in technology has allowed teams to communicate and work together at a distance and across time zones. Although a great deal of research has been done on teams, it is only recently that the need to study remote teams has been recognised. Many theories and models have developed from studying face-to-face groups but with new ways for teams to work, it was important to ask if these models and theories apply to remote teams.

Studies have shown that remote teams face challenges such as a lack of awareness in the group's activities (Andres, 1996; Steinfeld, 2002), limited social relations that can have an affect on trust (Walther, 1995; Steinfeld, 2002), difficulty in project management (Olson and Teasley, 1996; Benamati and Lederer, 2001; Evaristo, 2001; Steinfeld, 2002),and possible limited communication due to the technology used. (Bikson and Eveland, 1990; Dube and Pare, 2001, Newell, *et al*, 2001; Steinfeld, 2002). This thesis used previous theories and models but took into account other issues such as the physical distance between team members, the specifics of the task and the medium they used in communicating.

1.3. The Runestone Project Case Study

The case study used in this investigation was the Runestone Project, which is an international collaboration between Uppsala University in Sweden and Grand Valley State University in Michigan, USA. The primary aim for the Runestone Project is to introduce actual international experience into undergraduate Computer Science education in a way that has value for all participants. Incorporating an international project into courses at both Uppsala University and Grand Valley State University facilitates this aim.

For this project students are required to work in teams of 5-6 people. Each team contains members from each university. Students collaborate closely with their foreign counterparts using **Computer-Mediated Communication (CMC)**[2] technology to socialise, manage and negotiate solutions to a set task. This remote communication encompasses Runestone's secondary aim, to

> *identify effective support structures for remote international collaboration, encompassing strategies for communication, management and technology use. (Daniels, et al, 1998)*

Other objectives of the Runestone Project (Daniels, *et al,* 1998) are identified below:

As there are students from different cultures working together, the students will receive international contacts and valuable experience with multicultural teamwork.

Working with people from different cultures will also give students experience of collaboration with people from different educational backgrounds.

As the students collaborate and communicate with one another, they will experience learning through peer teaching.

Collaborating remotely in problem solving, students will experience use of information technology.

- Students will be prepared for the possibility of working in a foreign culture.

Further information on the Runestone Project is given in Chapter 2.

1.4. Why Study Collaborative Software Development in Remote Teams?

Technology has and continues to advance quickly. New methods and methodologies are continuously developed in order to improve the performance of software development projects where currently 2/3 of projects are late (Teasley, *et al*, 2000). Advances in technology have also brought about new ways of working, as remote software development is common in industry today (Andres, 1996; Benamati and Lederer, 2001; Dube and Pare, 2001; Newall, *et al*, 2001). It is important for academic institutions to keep

---

[2] **Computer-Mediated Communication (CMC)** - communication that occurs via the use of a computer.

up with the advances in technology and educate students in order to prepare them for real-world situations.

Projects such as the Runestone Project hope to help students gain the necessary skills such as working in remote teams, using technology to collaborate, working across time zones with different cultures, and collaborating in software development.

The research described in this thesis develops upon previous research and identifies specific patterns that characterise high or low performing groups. An understanding of how teams successfully build software at a distance and what characterises high performance in terms of software development in remote student teams will help students work more efficiently and effectively. Further work in this area could extend these benefits to industry as well.

1.5 Research Questions

The research interest generated a set of questions that would help to organise and focus the analyses. The research questions outlined below will be discussed in section 1.6 alongside the relevant chapter overview.

Do the group development models created for face-to-face teams apply to remote teams? (Discussed in Chapter 3 and Chapter 8).

How is performance assessed? (Discussed in Chapter4).

Does the amount of communication affect a team's performance? (Discussed in Chapter 5).

Are there any specific decision-making patterns that characterise high or low performing groups? (Discussed in Chapter 6).

What characterises the software development process of high performing and low performing teams? Are interaction[3] patterns specific to different phases of software development? (Discussed in Chapter 7).

---

[3] **Interaction** – In this context, interaction is the way team members act or behave with each other. All interactions in this study are considered as communication.

What characterises the interactions of high performance and low performance groups?
(Discussed in Chapter 6, Chapter 7 and Chapter 8).

Does interaction between only some members of the group achieve a successful result?
(Discussed in Chapter 8).

1.6 Overview of Thesis

This chapter describes the aim and motivation of the thesis as well as a description of each chapter. ***Figure 1.1*** below illustrates the structure of the thesis, with each box representing a chapter. The top part of the box gives the chapter number as 'C#' and the title of each chapter. The middle section gives key words describing the contents of each chapter and the bottom section identifies the research question it deals with.

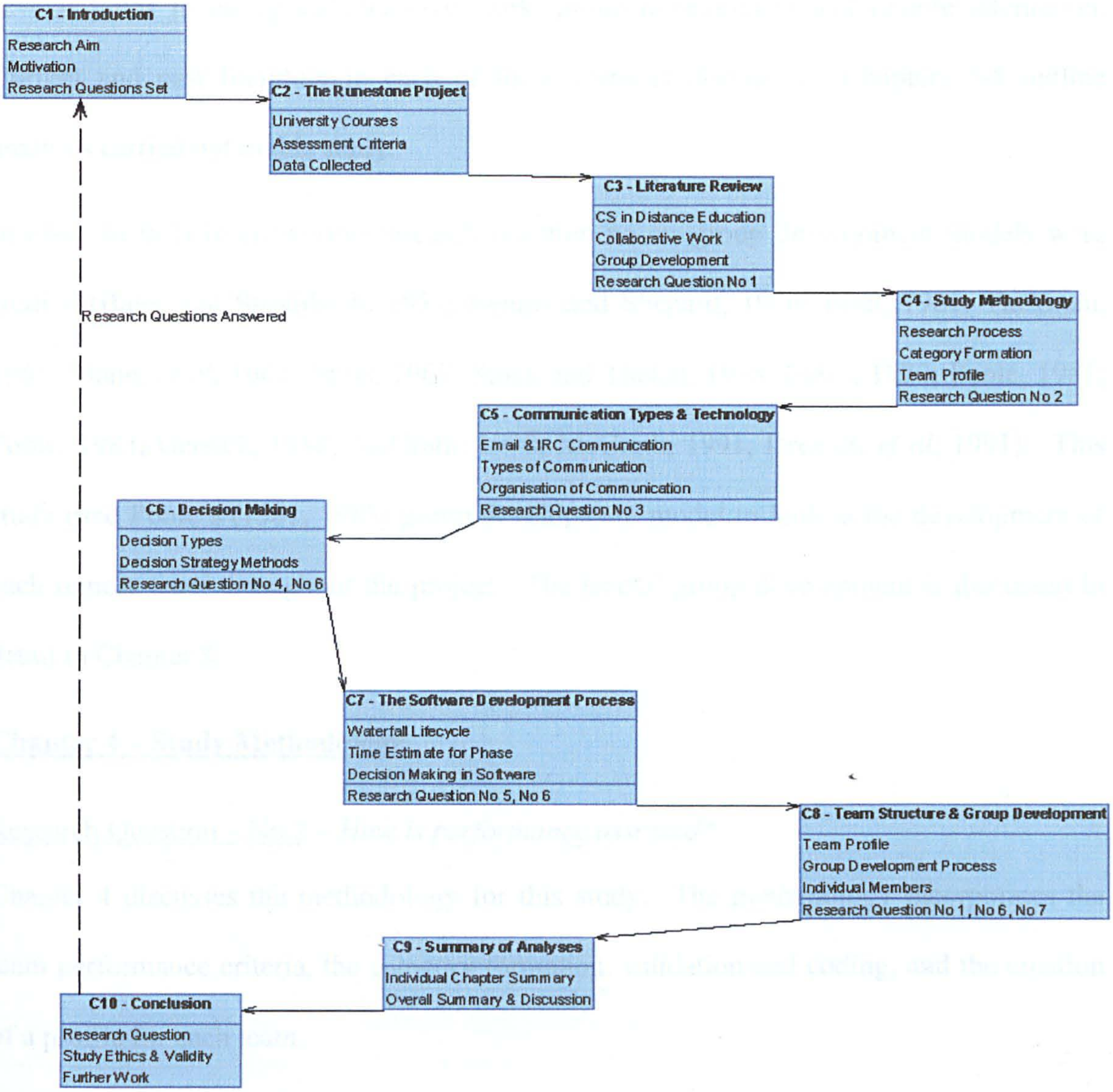

Figure 1.1 - Chapter Structure for Thesis

Chapter 2 – The Runestone Project

Chapter 2 describes the Runestone Project. It discusses the organisation and structure of the project in terms of the project task, the class structure, the creation of teams, medium used and data collected.

Chapter 3 – Literature Review

Research Question – No.1 - *Do the group development models created for face-to-face teams apply to remote teams?*

Chapter 3 discusses the literature that gives focus to this study. This study encompassed several fields including collaborative work, group development and remote interaction. Current and past literature in each of these areas is discussed. Chapters 5-8 outline analyses carried out in this study.

In order to help in answering research question no. 1, group development models were studied (Bales and Strodtbeck, 1951; Bennis and Shepard, 1956; Bion, 1961; Tuckman, 1965; Mann, *et al*, 1967; Mills, 1967; Stock and Thelen, 1958; Bales, 1970; Poole, 1981; Poole, 1983; Gersick, 1988; McGrath, 1990; McGrath, 1991; Drexler, *et al*, 1991). This study used Poole's (1981, 1983) group development model to look at the development of each remote team throughout the project. The teams' group development is discussed in detail in Chapter 8.

Chapter 4 – Study Methodology

Research Question – No.2 – *How is performance assessed?*

Chapter 4 discusses the methodology for this study. The methodology incorporates the team performance criteria, the category formation, validation and coding, and the creation of a profile for each team.

Performance is measured differently depending on the project and the environment. In industry, success in a project may be completing the project on time and within budget. In an academic environment, performance is measured by the final grade which is determined by the teachers who use criteria to identify the degree to which the course goals have been met. In order to identify high and low performing teams, this study looked at the criteria set for the course by the teachers and the grades given to each team at the end of the project. This is discussed in further detail in Chapter 4.

Chapter 5 – Communication Type and Technology

Research Question – No.3 - *Does the amount of communication affect a team's performance?*

Chapter 5 discusses the analysis of the use of communication technology. Because the teams were working remotely, their communication was electronic. Although teams were offered a range of technology to use for communicating, all teams used email and IRC (Internet Relay Chat) for their communication. The quantity of communication for each team was analysed as well as the breakdown of the technology each team used. Analysis showed that teams all had different amounts of communication and different amounts of email and IRC (Internet Relay Chat) use.

Each team communicated different amounts. Depending on their work and social habits the teams produced different types of communication. In order to see if the amount of communication affects a team's performance, this study compared the amounts of communication between the high and low performing groups.

Chapter 6 – Decision-Making

Research Question – No.4 – *Are there any specific decision-making patterns that characterise high or low performing groups?*

Research Question – No.6 – *What characterises the interactions of high performance and low performance groups?*

Chapter 6 discusses the analysis of each team's decision-making patterns. Analysis of decision-making identified specific types, quantity and timing of decisions during the project. Analysis of the quantity of decision types for each team is compared to the analyses of the quantity of the communication technology in Chapter 5.

Decision-making strategies in teams have also had a great deal of research. Using Hartley's (1997) decision-making methods, each team's decision-making methods are plotted and tracked alongside the software development process.

Chapter 7 – The Software Development Process

Research Question – No.5 – *What characterises the software development process of high performing and low performing teams? Are interaction patterns specific to different phases of software development?*

Research Question – No.6 – *What characterises the interactions of high performance and low performance groups?*

Chapter 7 discusses the analysis of each team's software development patterns. This analysis identified each team's software development phases in quantity and timing during the project. Further analysis compared the software development patterns to the decision-making patterns found in Chapter 6.

The software development process reflected in the structure of the project, as structured by the instructors, was the Waterfall Software Development Model (Pressman, 1992; Sommerville, 1992) and therefore was used to identify the stages of software development for each team. Each team had different work and interaction patterns and different software development processes. The software development lifecycle for each team is discussed in chapter 7.

Chapter 8 – Team Structure and Group Development

Research Question – No.1 - *Do the group development models created for face-to-face teams apply to remote teams?*

Research Question – No.6 – *What characterises the interactions of high performance and low performance groups?*

Research Question – No.7 - *Does interaction between only some members of the group achieve a successful result?*

Chapter 8 discusses the analysis of the individual team members. The analysis investigated each team's make-up via a team profile (a framework or description of the teams), the group development process, and the team structure in terms of the communication network and leadership style. Further analysis looked at the individual member's amount of communication and compared it to their grade ranking previously discussed in Chapter 4. The individual's grade ranking was also compared to the individual's decision-making process.

An analysis of interaction types, such as the task or social oriented communication was conducted on the group's development, software development and decision-making process. These analyses are discussed in depth in Chapter 6, Chapter 7 and Chapter 8.

Previous research has identified different structures of interactions in teams (Bavelas, 1948; Leavitt, 1951; Mills, 1967; Scott and Simmons, 1975; Tajfel and Fraser, 1978; Mantei, 1981; McGrath, 1984; Brown, 1985; Hartley, 1997). As teams work differently, they also interact differently. Some team communication sessions showed little or no interaction from one or more team members.

Chapter 9 – Summary of Analyses

Chapter 9 summarises the findings of the analysis carried out in chapter 5, chapter 6, chapter 7 and chapter 8. The summary compared findings of the low performing groups with the findings of the high performing groups and identified patterns in the communication, decision-making and software development of these groups.

Chapter 10 - Conclusion

Chapter 10 reviews the research questions addressed in this chapter and discusses the extent to which the questions have been answered. The study's limitations and generalisability are also considered. It concludes with a discussion of the contribution of this study and suggests the directions for future work.

Chapter 2

The Runestone Project

2.1. Introduction

The Runestone Project began as a three-year project sponsored by the Swedish Council for Renewal of Undergraduate Education. The aim of the Runestone Project was to introduce realistic experiences of international collaboration into undergraduate Computer Science education. The participants involved in the Runestone Project included students and faculty from Uppsala University, Sweden and Grand Valley State University, USA. Each university had a faculty member or teacher responsible for running the course that incorporated the Runestone Project. Teams (and individual students within the team) were evaluated by one of the teachers from either university. The number of teams varied from year to year depending on the number of students enrolled in each university course. (Daniels, *et al*, 1998)

This chapter describes the background and structure of the Runestone Project. It outlines the format and assessment of the university courses involved in the Runestone Project, and it introduces the running of the project during years 1999 and 2000. Although this chapter gives background information on the Runestone Project in general, this research used only the data gathered during the academic year 2000.

2.2. Runestone Project Researchers and Participants

Participants included researchers from the Open University (UK), including the author of this thesis, The University of Kent (UK), Uppsala University (Sweden), Grand Valley State University (US), St. Edwards University (US) and The University of Texas at Austin (US). All researchers were involved in the set up of the questionnaires and journals, and in the data collection. Each researcher was involved in a different project and was therefore interested in different areas than the other researchers. The researchers however, kept constant contact with one another. Some researchers, including the author of this thesis, published joint papers based on the different studies carried out via the Runestone Project. The researchers did not interfere with the organisation or running of the course.

2.3. The University Courses Involved in The Runestone Project

The **Brio Project** was the software development task (discussed in section 2.4) incorporated as part of each university course. In Sweden, the **Brio Project** was a portion of the Datorsystem II course and in the US, it comprised the CS 467 course. The **Brio Project** was designed to meet the Computer Science University requirements for each course at both universities. Undergraduate courses have a duration of three to five years in each university depending on the degree sought. US students were in their third or fourth year of undergraduate university study and Swedish students were in their third year of undergraduate university study.

A mismatch between the beginning and ending of the two university semesters meant a compromise of a ten-week duration for the project. The Grand Valley State University semester commenced two weeks prior to the beginning of the Uppsala University semester. As well, the Uppsala University semester ended in the middle of the Grand Valley State University semester. The ten-week duration of the course was *broken-up* by set deadlines for each project task component.

2.4. The Brio Project – The Software Development Task

The task set for the course for all academic years, called the **Brio Project**, was to design, build and implement a distributed, real-time system to navigate a steel ball through a pre-determined path by tilting the surface of the game board in two-dimensions with stepper motors. The user interface was presented through a web browser. The board and ball were a modified version of the well-known Labyrinth Game (shown in *Figure 2.1*).

A monochrome digital video camera focussed on the board was accessible to aid navigation. The user interface was presented through a web browser. Users who played the game specified a path for the ball to follow, then got feedback on the result of their run. The game server reset the ball on the board at each turn, executed the user's navigation algorithm, and then provided feedback to the user on the result of the run.

Feedback included information on how the navigation code executed and a graphical display of the path, which the ball traced on the board, compare to the desired path. The input to the navigation algorithm was the position of the ball. The output was the rotational positions of the motors as a function of time.

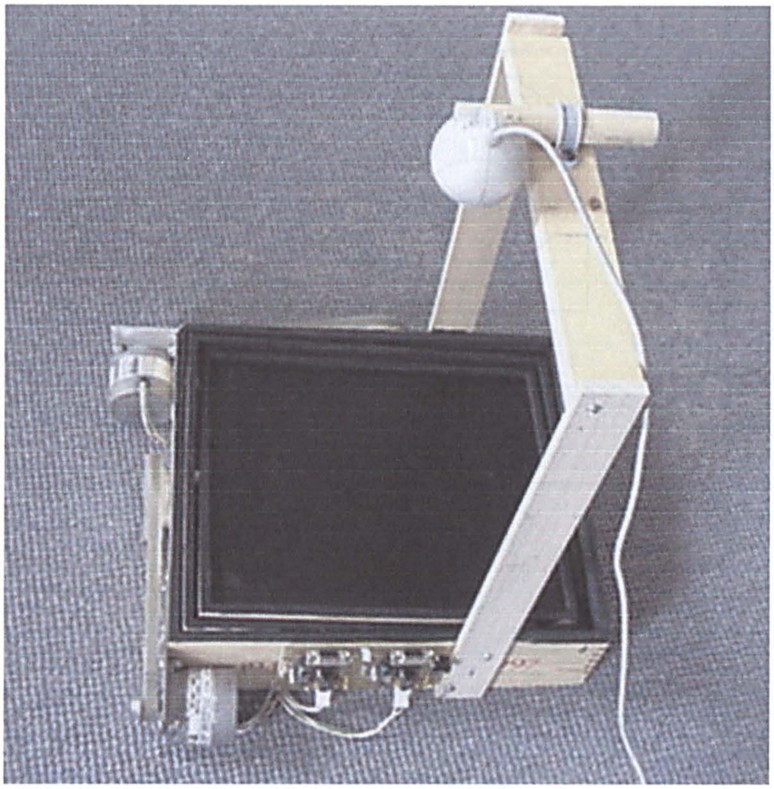

Figure 2.1 - The Brio Labyrinth Game

The students in each team were required to design and write the software components in the Brio Project. Because the project's duration was short, the architecture of the project was made available to the students via the Brio Project's website. The architecture as seen in *Figure 2.2* was composed of a client, servers and the hardware.

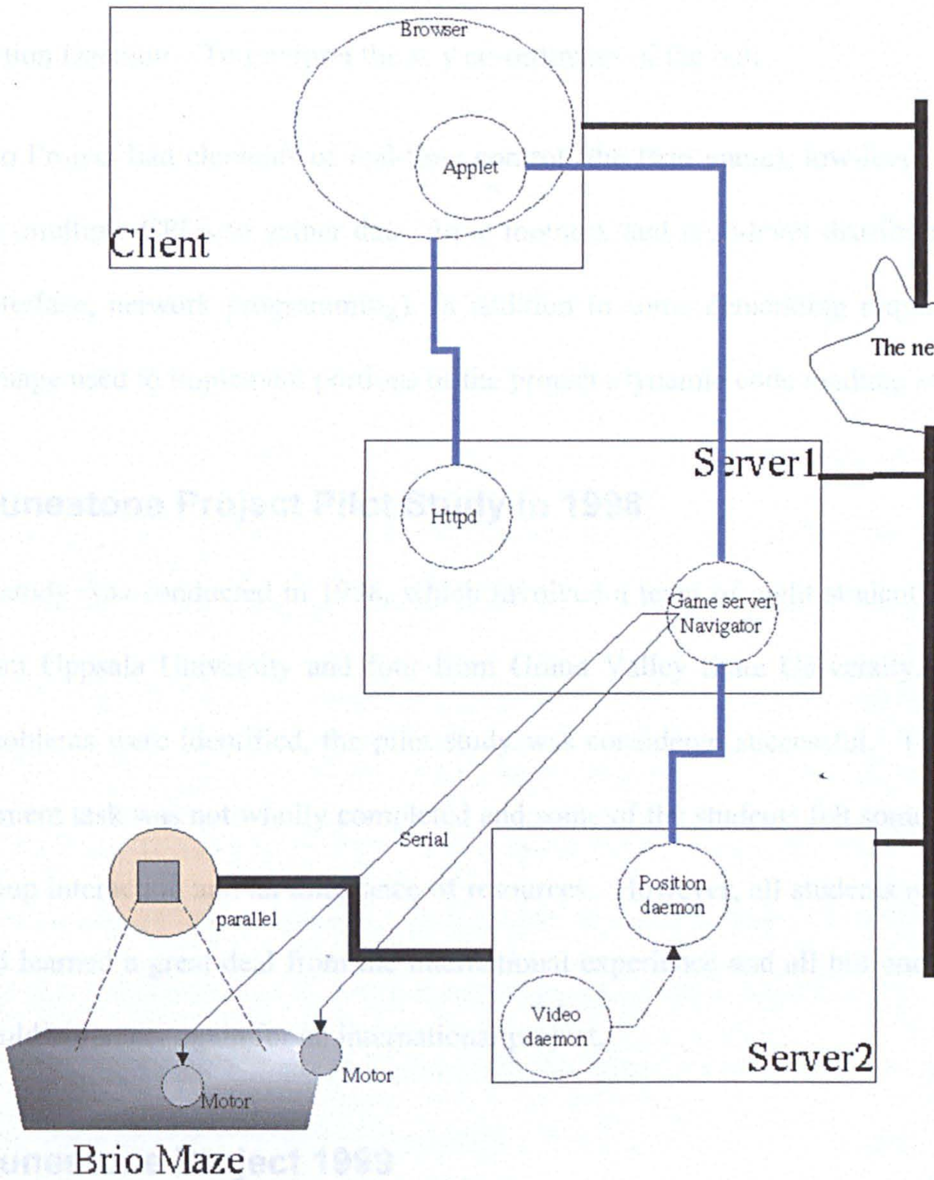

Figure 2.2 - The Brio Project Architecture

The blue lines represent software connections while the black lines are hardware connections. The students were given the choice of designing the project such that server1 and server2 could be distinct machines, or the same machine.

The project components are outlined below:

- Client Applet/Client – interface between user and game
- Server1 – Daemon like Java application

- Client/Server1 Connection – Communication between Client and Server 1
- Video Daemon – Sends images of the brio board set up to position daemon
- Position Daemon – To interpret the x, y co-ordinates of the ball

The Brio Project had elements of real-time control (the Brio game), low-level distributed systems (multiple CPUs to gather data, drive motors), and high-level distributed systems (web interface, network programming), in addition to some demanding requirements on the language used to implement portions of the project (dynamic code loading, security).

2.5. Runestone Project Pilot Study in 1998

A pilot study was conducted in 1998, which involved a team of eight student volunteers: four from Uppsala University and four from Grand Valley State University. Although some problems were identified, the pilot study was considered successful. The software development task was not wholly completed and some of the students felt some frustration with group interaction and an imbalance of resources. However, all students reported that they had learned a great deal from the international experience and all but one stated that they would volunteer again for an international project.

2.6. Runestone Project 1999

In 1999, the Runestone Project was implemented fully within the courses run at both Uppsala University and Grand Valley State University. This involved forty-two students, twenty-one from each university. There were seven teams with six students (three from each university) in each team.

Local sub-groups of three members were arbitrarily formed by the students themselves. The local teacher offered guidance where there were students unsure about joining sub-groups. Half of the local sub-groups in each university chose a team leader. Sub-groups with team leaders were arbitrarily matched with foreign sub-groups that did not have a team leader. This then formed international teams with half the team leaders in each of the universities.

Collaboration was conducted by communicating via the technology described in section 2.9. Face-to-face communication was also used within the local sub-group and with the local teacher. Teachers also used web pages to give information and guidance on course regulations. All communication was conducted in English and archived for research purposes.

The students' aim was to successfully complete the course task. One of the project requirements was to use both C and Java in the solution for the set task. Swedish students were more fluent in Java while the US students were more familiar with C programming.

The Brio Project (software development task) was mandatory for all students, however participation in the Runestone Project was a voluntary part of the course for which the student could gain bonus points. Participation in the Runestone Project included archiving all communication, filling in questionnaires, project logs and journals. Teachers were only informed that individuals had or had not completed the project requirements. They were not privy to the information given by the students. Approximately 90% of the students completed the Runestone Project requirements. These requirements included completing the questionnaires, journals, logs and peer evaluation.

The Brio Project result for 1999 was successful with all teams reaching completion. However, via the data collected for the Runestone Project, students identified several obstacles which they found obstructed their work process. These obstacles are identified by another Runestone researcher (Last, *et al*, 2000) in order of decreasing importance to the students.

- Poor communication
- Member non-participation

- Poor leadership
- Lack of technical skills
- Procrastination
- Differences in motivation

Although minor problems were identified with the implementation of Runestone Project 1999, it was seen as successful in that aims, such as learning to collaborate in an international environment were met. The meeting of its objectives gave encouragement to continue the project with Runestone 2000.

2.7. Runestone Project Year 2000

One aspect of the course that was changed in the year 2000 was that more frequent deadlines with smaller deliverables were set. It was hoped that this would allow dysfunctional teams to be recognised more quickly. The process of conflict and co-operation within teams could also be dealt with in the early stages of the project. Eight milestones were identified according to the task's components. There was a duration of one week between each milestone covering a specific task as outlined below.

Milestone	Task
M1 – Team set-up	Complete information on each team member and make available on the team homepage.
M2 – Creation of design and spec	Create a design document to serve as a 'blueprint' for project implementation.
M3 – Motor control	Demonstration of a driver program which plays the role of navigator and a motor controller program which receives data from the driver and positions the motors accordingly.
M4 – Video processing	Demonstration of a video processing server that adjusts the camera to the optimal setting, finds the ball in the video image and communicates the ball's position to the driver.
M5 – Server	Displays messages that illustrate the information sent to it by the client.
M6 – Navigation/Integration	Demonstration of the navigation algorithm and initial integration between client and server.

M7 – Client applet	Completed client applet, a stub or real server providing communication utilising the final Inter-Process Communication, and a test plan.
M8 – Final presentations	Demonstration of the final working system, and a description of the major modules.

The addition of more frequent deadlines added more clarity to what was required from the students. Web pages placed by the teachers gave specific guidelines on what each deliverable should contain, how to write reports, what was expected from the student presentations and what the assessment criteria were.

Differences between Runestone 1999 and Runestone 2000 were mainly administrative in that students were given more definitive milestones and guidelines about roles, assessment and deliverables. The actual task and idea of international collaboration remained the same. It was hoped that the changes made for Runestone 2000 would resolve many of the problems or obstacles seen in Runestone 1999.

This research focused on the communication and interactions of the Runestone 2000 teams. Any reference to assessment, data collection, team formation or technology is related to Runestone 2000.

2.7.1. Student Demographics for Runestone 2000

The year 2000 Runestone project involved ninety-three students, forty-seven from Uppsala University and forty-six from Grand Valley State University. There were sixteen teams in total, thirteen teams of six students (three from each university) and three teams of five students.

2.7.2. Team Formation for Runestone 2000

Team formation and leader choice for Runestone 2000 was similar to the previous year. In the US, the teacher who had some previous knowledge of some of the students' backgrounds gave them informal guidance. The aim was to form well-balanced teams in terms of experience and skill in software development and teamwork.

As part of the first milestone, the teams were encouraged to get to know each other by completing a team building exercise and putting up the results on a web page. The first milestone was to report on the team's roles, decision-making strategies, election process, interactions to date and problems to date.

All team members were required to take on the role of developers. The role of leader was clearly defined as an extended role where the person taking on that role would need to co-ordinate work as it progressed while still contributing work as a developer.

Presentations were required at the completion of each set milestone. Team members were required to take turns leading a presentation. All team members had to present at least once. Normally, the student who presented was also the student who had the main responsibility for the task that was being presented.

2.8. Assessment Criteria

Although assessment varied between the universities, it was conducted in the same way during all academic years. In Sweden, the mark given for the Brio Project was part of the final course grade, but, in the United States, the mark given was the final grade that the student received for the course. US marks are alphabetical gradations such as A+, A, A-, B+, B…D-, (skip E) and F. Anything received below a C (i.e. C-, D+, D, or D-) was seen as unsatisfactory and F was considered a failure. In Sweden the marks are numerical and do not have the same fine gradation as the US. Swedish marks are given as 5, 4, 3, and unsatisfactory.

The criteria for team and individual milestones, final functionality, final presentation and participation in the Runestone Project were outlined and made available to the students via web pages.

The criteria for **assessing milestones** is summarised as:

The presenting students must show:

- Evidence of organisation
- Effective involvement with other team members
- Effective use of media
- Well-written report

The criteria for **assessing final functionality** is summarised as:

The student must show evidence via:

- Brief summary of the major modules of the project (language, functionality)
- Brief summary of the IPC technology used in the project
- Detailed description of the navigation algorithm
- Detailed description of the video processing, and ball finding algorithm
- Any other chosen aspect of the project that is of relevance
- Demonstration of a working system

The criteria for **assessing the final presentation** is summarised as:

The student must show:

- Presentation management, organisation, use of tools
- Presentation content, quality and clarity of explanations, technical correctness
- Handling of questions of the opposite team, quality of questions

Runestone Participation required the students to complete:

- Questionnaires
- Logs
- Journals

The final marks were given to individuals by considering the calculated mark, which could be, adjusted +/- one grade level. Adjustment of the final mark was based on teacher opinion and peer evaluation.

<u>The calculated mark consisted of:</u>

- Final presentation (10%)
- Final functionality (20%)
- Team milestones (40%)
- Individual milestones (20%)
- Runestone participation (10%)

2.9. Technology Used by the Teams for Collaboration

In order to communicate, the teams in the Runestone Project used Computer-Mediated Communication (CMC). CMC can be text based as in electronic mail and bulletin boards or multimedia based as in video conferencing (Kaye, 1995; Paulsen, 1996). The teams were given a choice of different CMC technology, both text and multimedia based, to use. These included whiteboards, chat rooms, video conferencing, web pages, email and Internet Relay Chat (IRC). Although there was some use of video conferencing, this was minimal and was usually used in conjunction with IRC. The preferred forms of communication were email, IRC and web pages.

Students for all academic years were required to have weekly meetings and encouraged to keep regular contact with their teachers and other team members, both local and remote. For regular team meetings, students used Internet Relay Chat (IRC). Other correspondence with teachers or local or remote team members was via email. Web pages were used initially for introductions and to share personal information. They were later used to publish and make available project documents to the rest of the team.

In general, most communication was via email correspondence. However, messages were kept short and to the point. IRC correspondence was much lengthier and seemed to provide a venue for discussion and social interaction. Web pages were used more for sharing information that did not require an immediate response.

2.10. Data Collected

During each academic year, data was collected throughout the project in a variety of forms. Data collection was originally designed by the researchers and teachers in the universities mentioned in section 2.2 prior to the beginning of the pilot study in 1998. Data collection covered all types of interaction between team members except for informal face-to-face meetings. All researchers and faculty members had the opportunity each year to have input on changes or additions to the documentation used for data collection according to their individual interests. This research had input on information collected in the questionnaires for Runestone 2000.

The amount of information required from the students was organised in a logical format and kept to a minimum so that it did not add to a student's workload. The students were made aware that the information would not be shared with the course teachers, therefore allowing the students freedom of expression without any repercussions.

2.11. Chapter Summary

This chapter outlined the design of the Runestone Project and detailed the student demographics, the assessment criteria, technology used and data collected. It also identified the Brio Project as the student project, which involved developing software to control a mechanical labyrinth. The Runestone Project was identified as a research project studying how students work in international teams when completing the Brio Project.

The idea of collaboration within groups or teams of people is an issue that has been studied for many years in many disciplines (Olson, *et al,* 1992; Teasley and Rochelle, 1993; Barfurth, 1995; Belbin, 1996; Olson and Teasley, 1996; Hartley, 1997; Covi, *et al*, 1998;). This research developed upon previous research by looking at collaboration between students in teams developing software in a distributed environment. Research projects like the Runestone Project offer students experience in international collaboration and software building in a remote team environment. Students are expected to develop skills in software development that could be taken with them when they join the workforce. Consequently, the Runestone Project was uniquely suited to this research. It was chosen because it contained all of the elements necessary for this research.

Chapter 3 discusses the literature and gives a focus to this research. Chapters 5–8, give a more specific literature review relevant to the analyses performed in each chapter. Chapter 4 describes the design of the study conducted in this research.

Chapter 3

Literature Review

3.1. Introduction

Chapter 1 outlined the structure of the thesis and Chapter 2 described the Runestone Project. This chapter reviews the work of researchers in the areas covered in this research. The aim of this study was to examine the software development processes in distributed student teams, to look at the interactions among team members working remotely, and hence to characterise interaction patterns related to high or low software development performance. The field of interest for this research was in Computer Science in particular Software Engineering. Other areas included Collaborative Work, Group Development and Group Interaction. The following sections will discuss previous research in each of these fields and how it relates to this research. Investigation in these areas has generated several research questions that will be addressed throughout the study. These questions are outlined in Chapter 1.

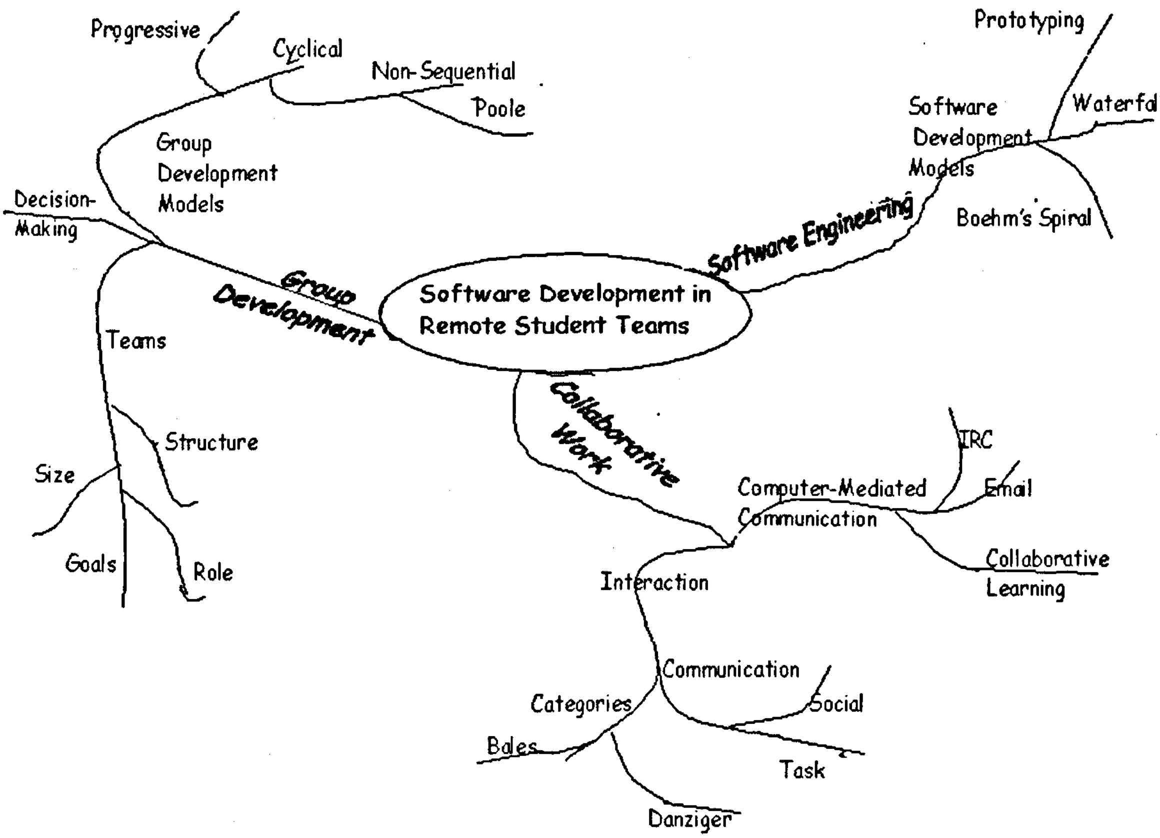

Figure 3.1 – Mind Map - Research Focus for Study

The organisation of the literature reviewed in this section is shown in the mind map above. *Figure 3.1* shows the fields of interest in this research study.

3.2. Previous Research on Software Development Process

Much work has been done over the past few decades to improve the way software is developed. Among the great diversity of studies, there are studies that looked into software process improvement (Nerur and Raghupathi, 1996), on group productivity in software development (Scott and Simmons, 1975), and on the understanding of programming goals (Weinberg and Schulman, 1974).

Other studies looked into the effect of human factors on software development (Basili and Reiter, 1979; Olson, *et al*, 1992; Covi, *et al*, 1998), applying the right techniques for software development using metrics to measure the quality of programming (Curtis, 1980), and the evaluation of programming language (Brooks, 1980).

Because of the great diversity of studies looking to improve software development there are also studies looking at the methodologies used for studying different aspects of software development (Brooks, 1980; Sarma, *et al*, 2003; Henderson, 2003). Results from these studies vary but a common suggestion among most studies is that continued research is necessary to continue to explore the challenges that software development projects face.

3.3. Understanding Software Engineering

> *Computer software is now critical to many businesses. It runs most modern factories...and is a key element in just about every product and service modern human beings use. As the business significance of software increases, the effectiveness of software engineering groups becomes progressively more important (Humphrey, 1997).*

Software engineering is the process of building software systems that include technical and non-technical aspects, by team collaboration rather than individuals (Andres, 1996; Sommerville, 2001). The job of software engineers according to Sommerville (2001) and Humphrey (1997) is to produce quality products for the expected costs, and to complete the work expected on the agreed schedule.

Nerur and Raghupathi, (1996) states that the

> *problems that plague software development cannot be adequately addressed until the entire software task is viewed as a process that can be planned, controlled, measured, and ameliorated.*

A **process** is defined as a series of steps or actions that define the way a project is to be carried out (Humphrey, 1997). A **software development process** is therefore a set of actions with specific phases (a subset of the process with pre-conditions and necessary inputs, a set of activities and the output produced by those activities) such as planning/designing, coding and testing that will result in a software solution.

Since their creation from other engineering disciplines in the late 1960's, many different variations of the software development process have emerged. Software projects can differ in many different ways depending on the project objective or goal and therefore may require a different methodology or software development process for each project.

> *Programming is such a complex activity that programmers have an almost infinite number of choices in terms of how they will write a program in order to meet certain specifications*
> *(Weinberg and Schulman, 1974).*

One common factor among all software development processes is that humans use them. Humans add a variety of individual cultures, experiences, knowledge, understanding and goals to the project team, which in itself can differ in size from project to project. Even if the project is the same for different teams, a variation of these factors will indicate a variation in the chosen methodology or software development process (Cockburn, 1999; Andres, 1996).

Armour (2001) states that

> *the nature of process for a creative group producing something for the first time should be different than for, say a product group producing the fifth in a series of system upgrades.*

Armour (2001) identifies 4 types of teams.

- *Tactical team* – who follow a plan and need defined roles and processes.
- *Problem solving team* – who solve problems and need defined roles and trust.
- *Creative team* – who build something new and need freedom from restrictions.
- *Learning team* – who construct a model of understanding and need consistent, shared models and language.

Although he identifies 4 types of teams with different goals and needs, he concludes that most software teams face the challenge that all types of processing are necessary. It is therefore important for teams to realise that they may not fall into one particular type but may need to combine the different processes involved in all the types.

The peril of not doing so is that the process will force the wrong answer. (Armour, 2001)

3.3.1. Software Engineering In Computer Science

The concept of **Software Engineering** was initially introduced at a conference in the late 1960's. It was derived from engineering principles and is concerned with the building of software systems by teams rather than by individuals. Teams incorporating Software Engineering need to be aware of the importance of project management and should be able to communicate both orally and in writing (Sommerville, 2001). It is not unusual for the process of software development to exceed the planned cost in both time and money. Effective project management is therefore crucial especially in student projects where time is limited to the length of the course (Bell, *et al*, 1992). Within the field of Software Engineering, the term **software** applies not only to the computer programming associated with the system but also with the documentation required to install, use, develop and maintain the system.

This study was concerned with **Software Engineering** from the point of view of software development in distributed teams. The distributed student teams were given the task of developing software, both the computer program and the documentation associated with it.

This study was concerned with investigating how student teams effectively build software at a distance and what factors characterise high performance in distributed student groups.

3.3.2. Software Development Process Models

Software development process models were developed from engineering activities (Royce, 1970). These models or **software Life-Cycles** are useful for describing the activities that are involved in the development of software provided it is recognised that they encompass many forms and variations (Royce, 1970; Boehm, 1988; Davis *et al.*, 1988). From this idea, software development process models such as the Waterfall Model

(Royce, 1970), Boehm's Spiral (Boehm, 1988), Prototyping, and PSP (Personal Software Process) (Humphrey, 1997) have evolved.

Organisations tend to adapt these models to fit their particular circumstances. The use of software development process models in the development of software systems varies greatly according to the developing teams, the project itself and other constraints. Although their use varies, it has been recognised that they are useful in determining what is required of the project, task assignments, project management deadlines and constraints (Bell *et al.*, 1992; Budgen, 1994; Sommerville, 2001). This thesis will not detail circumstances in which each one of these models is appropriate because of space limitations. For more information on these models, see the above references.

This study found that most of the students involved in the Runestone Project had either used the Waterfall Model incorporating iteration or had taken courses where the model was introduced. The Waterfall Model was also the model reflected in the course structure. Although the Waterfall Model has been adopted as a general standard in many organisations, it does have some limitations. If frequent iterations are used, it is difficult to identify management checkpoints. If there are not enough iterations, possible problems may not be caught in time (Sommerville, 2001). This could lead to an incorrect end product.

The students are required to adhere to the course deliverables. Since the Waterfall model is reflected in the course structure, the students follow the Waterfall Model for software development. However, it is the management of the process, i.e. length of each stage and the number of iterations that determine the success of the project. The Waterfall Model is compared with the project's milestones and used as part of the study framework in identifying the software development process of each team (Chapter 7).

3.4. Previous Research on Communication Media

In recent years, Information Technology has developed to a point where it can be used to facilitate the integration of geographically distributed organisations. Information Technology can overcome

> *time-space barriers to communication and hence promoting knowledge sharing.*
> *(Kelly and Jones, 2001).*

Although today's technology allows communication to and from geographically distributed individuals, issues such as, time-zone differences, multicultural and cross-organisational issues, language differences, group social development, group identity and group goal development and technology or media used in communicating still need attention. Depending on how these issues are dealt with they can become a problem (Benamati and Lederer, 2001; Kelly and Jones, 2001) or can be seen as benefits for communication and work improvement (DeSanctis, *et al*, 2001).

Technology used in distributed communication can be synchronous (immediate interchange of information) or asynchronous (delay of minutes, hours or possibly days before a reply is received). This research investigated synchronous communication in the form of IRC's and asynchronous communication in the form of Emails. DeSanctis, *et al* (2001), believes that

> *a mix of asynchronous and synchronous tools is vital to team success.*

As well as having a good *mix* of synchronous and asynchronous communication, it is important to the team's success that the team members

> *feel knowledgeable and comfortable with the use of various technologies so they can actively participate.*
> *(Dube and Pare, 2001)*

In this research, students were given a choice of different technology to use for communication and they chose those that they were most familiar with or able to learn quickly.

3.5. What is Collaborative Work?

To collaborate is to work with one or more persons on a joint project. It requires participants to engage in a co-ordinated effort to perform a task or solve a problem together (Teasley and Roschelle, 1993). Although it is important to have a common goal (Barfurth, 1995), the goals of the individuals collaborating on a project are not necessarily the same. Collaboration on projects can vary depending on the project itself and the type of collaboration required.

A project is defined by Little (1983) as a

> *mission, a set of activities in the service of a goal or goals.*

Projects can come from different areas of industry or education and therefore the goal for each project differs. The project in this study was concerned with an educational project, which involved the development of software. The students were required to collaborate in order to complete the software development project. The common goal was the successful completion of the project. However, this study investigated both team goals and individual goals as part of analyses carried out on each team's profile and group development process (Chapter 8). For the purposes of this study, collaboration will be defined as the

> *mutual engagement of participants in a co-ordinated effort to solve the problem together (Roschelle and Teasly, 1995).*

3.5.1. Computer-Supported Collaborative Learning

A great deal of research has been devoted to the area of **collaborative learning** (Littleton and Hakkinen, 1999; Schwartz, 1999; Kraut and Egido, 1990; Dillenbourg *et al*, 1999; Alexander, 1999). According to Forman and Cazden (1985), **collaborative learning** is a term frequently used when generally describing the results of collaboration in education.

Student collaboration within groups was essential for this study as it was required as part of the course. Students therefore had to work with other students in set groups in order to reach their goals. Another requirement of the course was that the students work in a distributed environment. The Runestone project had partial distribution of team members. Partial-distribution in this situation was where half the student group was located within the same physical location and the other half was at a distance.

Collaboration requires communication between the distributed members of the group.

> *Throughout the history of human communication, advances in technology have powered paradigmatic shifts in education*
> *(Frick, 1991).*

Computers have enhanced the communication between distributed student groups with tools such as email, Internet, Internet phones, videophones etc. O'Malley (1992) identifies three main roles for the computer in collaborative learning.

> *1. Learning around the computer where the computer is used for reflection on a joint activity.*
>
> *2. Learning through the computer where the computer is used to support communication.*
>
> *3. Learning mediated via the computer where the computer aids the collaborative learning process by supporting both communication and joint activities.*

Using O'Malley's definition, this study defined the role of a computer as role number 3. Because the students in this study were partially remote, face to face communication was not possible for some team members, therefore the computer was used as a crucial tool for communication. Although the computer was 'used to support communication' (as stated in role number 2), the computer was also supporting joint activities such as the development and sharing of software. Chapter 5 analyses in depth the amount of the communication technology used by each of the teams.

As this study involved an educational project, collaborative learning was assessed by the final results and tutor feedback for each group and not necessarily for the individual. Each team's performance was analysed by the marks they achieved. The teams were identified as high or low performers according to their team mark ranking (Chapter 4).

3.5.2. Communication Tools for Computer-Mediated Communication

Communication tools enable communication between groups who are physically distributed or who participate at different times. Communication tools in the context of this research will refer to **computer-mediated communication** (CMC).

The use of CMC in organisations and education has increased over the recent years. Research studies in this area have also increased (Dennis, *et al*, 1988; Ancona and Caldwell, 1990; Bikson and Eveland, 1990; Mandviwalla and Olfman, 1994; Mark and Wulf, 1999; Clear and Daniels, 2003; Daniels, *et al*, 2003; Herder and Sjoer, 2003; Thomas, 2003).

Research has shown that the use of computer-mediated communication (CMC) has made an impact in both positive and negative ways. According to Bikson and Eveland (1990), when team members use computers to communicate rather than face to face communication, aspects such as structure, intensity of communication and work process could change. Finholt, *et al* (1990) propose that more use of computer mail can aid in the organisation of team activities and increase participation.

Other studies show that computer-mediated communication has been a useful communication tool in distance education (Budny, *et al*, 2003; Gross, *et al*, 2003; Ponta, *et al*, 2003) It has aided in the delivery of courses and alleviated problems of isolation and lack of interaction (Davies, 1995; Henri, 1995). Problems encountered with the use of communication tools such as computers include hardware limitations, software limitations, user resistance and lack of ability to choose and apply the right tool for a given task (Hansen, *et al*, 1999).

Research has also generated a need for better designed, better-used and better-supported systems (Mark and Wulf, 1999). Gutek (1990) proposed a structural contingency theory that suggests a group must fit its technology to the structure of its tasks in order for the group to be effective. Having the right technology for the group to complete the task is seen as important. Although this research does not investigate the fit between the technology, the groups and the task, it does look at the use of email and IRC by each group to accomplish a software development task.

Mandviwalla and Olfman (1994) suggest that groupware systems don't yet match the work required by distributed teams and have therefore proposed a set of generic GroupWare design requirements. Andriessen (2002) proposes that many groupware applications are built without considering what the users can handle or need for their work and therefore these applications often do not function according to expectations. More recent studies such as Preece and Maloney-Krichmar (2003) focused on *'how knowledge of sociability and usability can be used in online community development'*. As a result of this study they propose a community-centered development method and a framework for sociability and usability. Olson and Olson (2003) state that there are a large number of specific groupware-based commercial products such as several email applications, Lotus Notes and Netmeeting. They suggest that

> *Groupware functionality will become widespread and familiar. However, there are still many research issues about how to design such systems and what effects they have on the individuals, groups and organisations that use them.*

This research was set in a distributed group environment and therefore communication tools such as the computer were crucial. This research recognised that there is a great deal of improvement still required from these tools, however it does not concentrate on the usability of the groupware used in this study. The students in the Runestone Project were given the choice of different tools for communication. Internet Relay Chat (IRC) and email were used to communicate more than any other available tool. This research investigated the differences in the use of the email and Internet Relay Chat (IRC). However, it did not study the pros and cons or the problems associated with the use of the hardware or software used in the Runestone Project. Analysis of the use of communication media is discussed in Chapter 5.

3.6. Interaction Types in Group Communication

A common factor in most of the studies on group interaction and group development is the idea that during a group's existence there are functions, interactions and/or communications that could be identified as having a **task** or **social** interaction (Bales and Strodtbeck, 1951; Tuckman, 1965; Poole, 1981 and Walther, 1995). Tuckman (1965) viewed this as

> *the realm into which the group behaviour falls at any point in time, that is, task or interpersonal (social.)*

He does however, warn that depending on the group's goals, the distinction between task and interpersonal (social) interaction may be obscure.

Specific groups such as the ones in this study have the purpose to accomplish a task. **Task interaction** is therefore vital to the success of the project or task to be achieved. **Social interaction** is important, as membership of a social group is an essential aspect of an individual's personal identity (Bales and Strodtbeck, 1951; Tuckman, 1965; Poole, 1981 and Walther, 1995). A group's behaviour and norms (ideas about how people should act, feel and express their feelings) are produced through a group's social interaction. These norms later act as a frame of reference for the individual members (Hartley, 1997). Depending on the individuals of a group, the circumstances and the task, the ratio of task oriented interaction with social oriented interaction could vary.

This research (Chapter 5) investigated how these types of interaction, social and task oriented affect the team's development, the product creation and the outcome.

3.6.1. Interaction Via Communication in Groups

Collaborative work involves mediation by some form of communication. Krauss and Fussell (1990) regard communication as a process by which knowledge that resides in one or more people comes to be represented in one or more other people. Communication between multiple team members needs to maintain some degree of mutual understanding. According to Flor (1998), common ground: mutual understanding, mutual knowledge, mutual beliefs, mutual assumptions and mutual presuppositions, is necessary for effective communication. **Grounding** is the process by which individuals in a group maintain a common ground in communication (Flor, 1998;Baker, *et al*, 1999).

Advances in technology have allowed groups to work together in physically distributed environments (Andres, 1996; Benamati and Lederer, 2001; Dube and Pare, 2001). This means however that in order to communicate remotely, team members must use some medium to interact and communicate with each other.

Communication can be exercised via different channels such as face to face, computers, paper, telephone and videophone. As mentioned earlier, there are many educational projects which use computer-mediated communication and involve virtual teams. As well as educational institutes, there are many organisations that use virtual teams. As with the educational projects, different areas of virtual team working in organisations has also been studied. Newall, *et al*, (2001) found that cultural and social changes should accompany and complement technological changes. Steinfield (2001) studied the benefits and challenges of virtual team working and suggests that *'a robust communication infrastructure that addresses group needs is critical'* in virtual team working. Lipnack and Stamps (2000) also look into challenges and problems faced by virtual teams. As well as identifying problems, they give suggestions on how to deal with the problems. They suggest that problems like a virtual team member refusing to participate should be dealt with in the same manner as a face to face team member.

In some organisations, virtual teams incorporate members from different geographical parts of the world. Canney Davidson and Ward, (1999), state that international teams are different from other teams because the participants hold passports from different nationalities and this difference can add a layer of complexity to the team's interaction. Not only do virtual teams face cultural, social and communication challenges as detailed above, but they also face challenges with possible problems that arise from the project. This study deals with software development. Karolak (1998) and Benamati and Lederer (2001) state that virtual software development projects are more complex than face to face software development projects. Karolak (1998) compared the software development life cycle in a traditional (face to face) environment with that in a virtual environment. He concludes by stressing that

> *Managers must be constantly aware of new developments and adjust their methods and practices accordingly.*

The study in this research has some elements similar to the studies described above. This study looks at virtual international teams developing software. However, the teams in this study are not in an organisational environment but rather an educational environment. Therefore there are several differences. The time scale for the research in this project will be much shorter than that in an organisation. The students in this project will have as a 'manager' the teacher in charge of their group who will be grading them on a weekly basis (more information on marking is given in Chapter 4). The performance criteria for the students will be different from that of another group in a organisational environment. The performance criteria for the students (Chapter 4) were based on the final grade whereas the performance criteria for an organisational group are more likely to be to finish the working software on time and within budget.

The medium used for the remote communication in this study was a computer, running email and Internet Relay Chat (IRC). The possibility of using different channels for communication also allows the flexibility of having synchronous and/or asynchronous communication. The student teams in this study had access to asynchronous communication via the use of email and synchronous communication via the use of Internet Relay Chat (IRC).

3.7. Research on Communication Analysis Methods

Methods for analysis of communication in teams range from ethnographic methods to categorisation and classification of their behaviour. One of the most popular methods for recording communication and interactions in the group is the Interaction Process Analysis (IPA) developed by R.F.Bales in the 1950's. In developing IPA, Bales identified an **act** as the

> *smallest meaningful and discriminable piece of behaviour which an observer can detect (Bales and Strodtbeck, 1951)*

Bales proposed three basic ideas about groups, which can provide a model for categorising interaction.

> *1. The small group is a social system – all major processes that occur in social systems can be discovered by investigating small groups.*
>
> *2. There are fundamental issues that every group must resolve – distinction between task problems in the task area and problems in the socio-emotional area.*
>
> *Tasks area Problems*
>
> *Communication*
>
> *Evaluation – working out which ideas to reject and accept*
>
> *Control – keeping up to date with the task demands*
>
> *Socio-emotional area Problems*
>
> *Decision – how members show agreement/disagreement*
>
> *Tension Reduction – if members are joking, laughing, use humour*
>
> *Reintegration – how members show solidarity and support others.*
>
> *3. Observe and Classify group behaviour on these lines – six major problems are identified by Bales. Each has a positive and a negative side, i.e. communication information is given or requested. This then gives the 12 categories.*

Bales's model is dependent on observations and classification of the members' overt behaviour. According to Hartley (1997), Bales's categories may be too global. The categories were created to cover every situation, however, they may not distinguish between **acts** that should really be seen as distinctive in a particular situation. There is also no scale of intensity for Bales's categories. The categories developed for this research were developed in layers or levels. The top-level contains a general category such as 'planning'. The sub-levels contain more detailed descriptions of the top-level such as 'the different types of planning'. The scale of intensity in the categories developed in this research (Chapter 4), lies within the top-level and sub-levels. For example, 'planning' using Bales's categories does not distinguish what type of planning. The categories in this research gave 'planning' a top-level label and a sub-level label, which identified the type of planning being discussed.

Another method for analysing communication is that of Kurt Danziger. Danziger (1976) developed a method for analysing rhetorical codes in conflict situations. His basic idea is that

> *we must base the classification of verbal utterances on the role that they play in the social interaction within which they occur.*
> *(Hartley, 1997)*

Four basic functions of human communication were identified:

1. To teach – communicate to inform

2. To please – communicate to satisfy emotional needs and develop friendships

3. To move – communicate to make things happen.

4. To defend oneself – communicate to justify actions by responding to any perceived attacks.

These functions are used to generate twenty-nine categories presented in a tree diagram or algorithm. The coder will work down the tree until reaching the category that best fits the utterance. This coding method identifies utterances as relevant or irrelevant and dismisses that which is deemed as irrelevant.

Danziger's model is dependent on extensive interpretation of what is happening within the group. Danziger's model is not considered too global however, Hartley (1997) suggests that all categories must have a 'unit of observation' in order to make a decision as to how far to divide what is being categorised. Interpretation of behaviour must also be taken into account when categorising. Categorisation developed for this research (Chapter 4) takes into consideration Hartley's suggestion regarding 'unit of observation' and interprets behaviour in the context to what is happening within each group meeting.

Classification and categorisation of the communication generated in this research was undertaken in order to identify each team's actions, development, roles, and interactions. The development, validation and analysis of categories developed for this study is discussed in Chapter 4.

3.8. Previous Research in Group Development Process

According to McGrath (1984) a group consists of

> *two or more people, who have some prior relationship with one another and an expectation of some future relations, doing something together.*

Hartley (1997) believes that a group is more than the sum of its component parts. A group consists of not only different people but also the different relationships among those people, the situation and the goals (Thelen, 1968; Hartley, 1997). Groups are dynamic entities that can be found in different areas of life. Groups are usually formed with a common purpose towards which all team members work together. The teams involved in this study were not formed for the purpose of this research but rather as part of a course assignment.

Further studies on groups developed a great deal of information on team structure (Bikson and Eveland, 1990; Bennatan, 2000), communication networks (Mills, 1967; Scott and Simmons, 1975; Mantei, 1981; Brown, 1985; Leavitt, 1951; Hartley, 1997), leadership styles (Mantei, 1981; Belbin, 1996; Bennatan, 2000) and individual and team goals (Mills, 1967; Weldon and Weingart, 1993). The results found in previous team research was taken into account in this research and applied to the analyses outlined in the following sections.

3.9. What is Group Development?

The previous sections identified relevant terms and placed this study in the context of collaborative work in Computer Science. The following sections will identify previous research in Group Development. Previous group development models are outlined and placed into the context of the Runestone Project.

3.9.1. Identification of Groups

In studying teams, researchers have classified different types of teams. Tajfel and Fraser (1978) identify four main groups.

- <u>Family groups</u>
- <u>Friendship groups</u>
- <u>Work groups</u>
- <u>Laboratory groups</u>

Hartley (1997) further identifies a new group called the <u>self-study group</u>.

McGrath (1984) classifies groups as

<u>Natural groups</u> which include families, work crews etc. (this is similar to Tajfel and Fraser's 'family, friendship and work groups').

<u>Concocted groups</u> that are created for the purpose of research studies (this is similar to Tajfel and Fraser's 'laboratory groups').

Quasi-groups that are also created for research study (this is similar to Tajfel and Fraser's 'laboratory groups').

The difference between the concocted groups and the quasi-groups as McGrath explains, is that in the concocted groups individuals (although assigned) are actually working together on tasks. However, in quasi-groups there is a great deal of restriction on the task performance process and the interaction within the group.

The teams involved in this study were not formed for the purpose of this research study but rather as part of the course assignment. The groups therefore could not be considered laboratory groups (Tajfel and Fraser), concocted or quasi-groups (McGrath). The students chose to enrol in these particular courses but had some guidance in assignation to a group. In the sub-group formation where the students were co-located, many of them chose to work with their friends so they could be considered friendship groups (Tajfel and Fraser) or natural groups (McGrath).

The students were given a choice to take part in the study. The work in a team environment had to be completed regardless of their participation in the study. The groups could therefore also be considered self-study group (Hartley) and work groups (Tajfel and Fraser). This study investigated the groups' development, dynamics and backgrounds and the identification of group types for this study was considered part of this investigation.

3.9.2. Research on Group Development Models

Groups are made up of individuals whose behaviour and performance vary depending on different characteristics such as experience, backgrounds, group dynamics, etc. occur within the group. According to Mennecke, *et al* (1992), group development refers to the

> *degree of maturity and cohesion that a group achieves.*

Research in the area of group development has resulted in many different models and theories that both complement and contradict each other. The research referred to here means research in a global sense, not this thesis in particular. One purpose of this research was to enable positive change in teams, which will in turn result in effective outcomes of projects. Hartley (1997) identifies four different theories of group development.

1. That groups go through a sequence of stages in a specific order.

2. That groups go through a sequence of stages but their order may vary.

3. That groups alternate between different states.

4. That groups change their central focus as they develop.

Mennecke, *et al* (1992) classified the numerous group development models into three different types: progressive (unitary) models, cyclical models and non-sequential models.

Progressive Models

The progressive or unitary models suggest that groups display an increasing degree of maturity and performance over time. Two models included in this category are the Equilibrium Model and the Linear Progressive Model.

- The Equilibrium Model (Bales and Strodtbeck, 1951; Bales, 1970) states that groups are systems which need to maintain an 'equilibrium' between instrumental (task-related) needs and expressive (socio-emotional) needs.
- The Linear Progressive model (Bennis and Shepard, 1956; Tuckman, 1965) assumes that groups develop in a "definite order of progression" and go from one phase to another. Bennis and Shepard's (1956) model states that groups move between the dependence phase (relationship to authority) and the interdependence phase (relationship with peers). Tuckman's (1965) model assumes that groups develop via a progression through four stages (forming, storming, norming, performing – with the later addition of adjourning). Each of these has interpersonal relationship and task behaviour.

The linear progressive model is consistent with Hartley's theory number *1-that groups go through a sequence of stages in a specific order.* Both assume that groups go through specific phases in a specific order.

Cyclical Models

Cyclical models assume a linear sequence of events that are similar to other Life-Cycle models. The models included in this category are the Life-Cycle Models and the Recurring Cycle Models.

- Life-Cycle Models (Mann, *et al*, 1967 and Mills, 1967) assume that groups develop in a manner similar to an individual's life cycle, that being birth, growth and death.
- Recurring Cycle Models (Bion, 1961; Drexler, *et al*, 1991; Stock and Thelen, 1958) state that groups will continually fluctuate between various issues and concerns, and resolution of issues is temporary or partial.

The Life-Cycle model (Mann, *et al*, 1967 and Mills, 1967) is consistent with Hartley's theory number 3 *that groups alternate between different states.* Although both the cyclical models and the linear models assume a linear sequence, there is a subtle difference. Linear models such as Tuckman's, suggest that groups go through specific phases or stages such as storming, norming, in a particular order. Cyclical models such as the Life-Cycle model assume that groups go through non-specific events or occurrences such as birth, growth, death, in no specific order. A Life-Cycle model is cyclical in that they have a terminal phase prior to group dissolution or regeneration.

Non-Sequential Models

Non-sequential models do not specify any particular sequence of events, as do the Progressive Models. Non-sequential models suggest that events occur as a result of contingent factors that change the focus of the group's activities. These models include the Punctuated Equilibrium Model, Time, Interaction and Performance (TIP) Model and the Contingency Model.

- The Punctuated Equilibrium Model (Gersick, 1988) posits that groups work to a point of transition exactly halfway between the time they begin and the time they end their work. At the halfway point, the groups change focus and work processes.

- Time, Interaction and Performance (TIP) (McGrath, 1990, 1991) assumes that groups are *multi-functioned* and that they will always act in one of four modes (Inception, Problem-solving, Conflict Resolution and Execution) for each of three functions (Production, Well-Being and Member Support).
- Poole's Multiple Sequence Model (1981, 1983) assumes there are different developmental sequences for different groups. This implies that groups take different paths depending on the ensemble of conditions at a given point in the problem-solving process.

All non-sequential models are consistent with Hartley's theory number 2 *that groups go through a sequence of stages but their order may vary* because they do not follow a specific sequence. They are also consistent with Hartley's theory number 3 *that groups alternate between different states* because events occur as a result of contingent factors. Therefore, they alternate between different states. Hartley's theory number 4, *that groups change their central focus as they develop* is more consistent with the Gersick's Punctuated Equilibrium Model.

3.9.3. Comparison of Group Development Models

The Non-Sequential models described in section 3.9.2 are more recent developments than the Progressive or Cyclical models. Mennecke, *et al* (1992) point out that all these models with the exception of the Punctuated Equilibrium Model (Non-Sequential) possess similar stages. Mennecke, *et al,* Bales, and Poole identify a stage called 'orientation', which equates to Tuckman's 'forming' stage and Mill's enactment stage. Due to space limitations, this thesis will not detail each model's phases. These can be found in the references stated above.

Although the models have similar stages, the way groups go through the stages differ. Gersick (1988) suggests that the Progressive and Cyclical models were created under the assumption that groups posses 'an inherent static developmental nature' that does not respond to the demands from the environment. Poole (1981, 1983) posits that the phases in a rigid Progressive model are probably representative of unique cases rather than the norm. Hartley (1997) further suggests that in a model such as Tuckman's, the 'storming' phase could be deflected from unnecessary conflict if the problem is openly discussed therefore bypassing the phase. Mennecke, *et al* (1992) suggests that these models deviate from the basic stages because of

> *the coding methods used to analyze the meeting process and the presence or absence of particular contingencies that influence group development.*

In analysing his model, Poole divided the time of the study group meetings into short duration segments. Other researches divided the time into long, fixed duration. Poole and Roth (1989a, 1989b) felt that other researchers' division of time may make the observed phases more of an artefact of the segmentation process rather than the existence of actual phases.

Having investigated the different models, this research chose Poole's Multiple Sequence Model as a guide to each team's group development. Poole's model is consistent with the Waterfall Life-Cycle, especially with regards the use of iteration, and can therefore track the group development (what is happening with the group) alongside the software development. Analysis also investigated if one had an effect on the other. Poole's Multiple Sequence Model incorporates variations between groups in the occurrence, ordering and number of developmental stages.

Poole's Multiple Sequence Model is discussed in more detail in Chapter 8.

3.10. Team Structure And Role Identification

Teams cannot produce effective work without some structure whereby members are clear about what they are supposed to do. A good structure and clear identification of roles is important to the cohesion and advancement of the team. McGrath (1984) states that differentiated roles and patterns of behaviour within team members can lead to the development of expectations for how each team member should behave and what their responsibilities are. There are several roles in teamwork that must be fulfilled and all roles are considered valuable. Chapter 8 describes the investigation of each team's structure and role identification of each student within the group.

3.10.1. Team Interaction And Behaviour

Interaction among team members is inevitable and necessary. Individual members will have some sort of relationship with other member(s). Mills (1967) identified five levels of interpersonal processes that are different and distinct in teams.

> *1. Behaviour – relates to how individuals act with one another.*
>
> *2. Emotions – relates to an individual's feelings towards others. Seen as a driving force.*
>
> *3. Norms – ideas about how people should act, feel and express their feelings.*
>
> *4. Goals – what is most desirable as a unit to do.*
>
> *5. Values – what is most desirable as a unit to be and to become.*

The way team members interact with each other can have positive and negative influences in how the team functions. Through interaction, teams will eventually develop norms and rules of behaviour (Mills, 1967). For this study, each team's interaction and behaviour is considered in the category types that are outlined in Chapter 5 and in each team's interaction network described in Chapter 8.

3.11. Decision-Making in Teams

For many years, researchers have studied the development of decisions in groups. Research on decision development in teams can be divided into three categories.

- Unitary
- Multiple
- Complex

- The first category supports the unitary sequence model, which shows a single, set sequence of phases. Bales and Strodtbeck (1951) proposed the classic model of decision development as a unitary sequence of three phases - orientation, evaluation and control. The unitary sequence model implies that most groups follow an identical sequence of phases. Later work (Landsberger, 1955; Heinecke and Bales, 1956; and Morris, 1970) supports the Bales and Strodtbeck unitary sequence model. Fisher (1970) and Tuckman (1965) have supported other unitary models. They each identified phases similar to those of Bales and Strodtbeck.

- The second category of studies supports the multiple sequence model of decision-making, which assumes the possibility that different groups follow different developmental sequences. Poole (1981) conducted a comparative test of the unitary and multiple sequence models. He found significant development differences between the groups studied thus supporting the multiple sequence model theory. The multiple sequence model suggests that differences in groups' development can be explained by

  contingency variables which lead groups to take different paths.
  (Poole and Doelger, 1986).

- The third category of studies believes that group decision-making is much more complex than the unitary or multiple sequence models allow. Research (Poole, 1983; Mann, 1966; Segal, 1982; Scheidel and Crowell, 1964; and Berg, 1967) has found that as with the group development, decision-making in groups is much more complex than the unitary and multiple sequence models envision. It was found that in some instances it would have been inaccurate to describe the decision-making behaviour as coherent

Poole (1983) proposed a theoretical model to reconcile the three categories of studies previously discussed. Rather than viewing the decision-making process as a series of phasic blocks that follow one after the other in a sequence, the proposed model portrays development as a series of

> *intertwining threads of activity which evolve simultaneously and interlock in different patterns over time.*
> *(Poole and Doelger, 1986)*

Poole proposed looking at three threads.

- Task process activities (problem analysis and solution evaluation).

- Relational character (activity patterns that reflect working relationships among group members at any given point).

- Topical focus (other issues being dealt with in the group activities).

Poole also added three types of **breakpoints** (intermittent casual processes providing temporary direction to the group interaction) to complete the descriptive model (Poole and Doelger, 1986). These breakpoints include:

- Normal breakpoints such as topic shifts and adjournments that provide breaks without disrupting group activities.
- Delays during which the group cycles back to repeat or rework previously completed points.
- Disruptions which occur when a major conflict halts progress or when failures cause the group to reconsider its work.

Poole's 1983 theoretical model, which reconciles the three categories of decision-making studies, is consistent with his group development model. Although Poole (1983) believes that the group decision-making process is more complex than the group development process (described in section 3.9.2), there are similarities between the two models. Both models show that teams don't follow any pre-determined pattern. Both Poole's Multiple Sequence Group Development Model (1981, 1983) and Poole's Theoretical Decision-Making Model (1983) suggest that the groups go back and forth showing iteration between phases. The two models also show that groups take different paths in their group development or decision-making depending on what is happening in the group.

In looking at how teams make decisions, this research took into account Poole's Theoretical Model regarding the process teams go through. This research however, was not interested in looking at the group's decision-making phases, such as an orientation or conflict phase (Poole and Hirokawa, 1986) but rather the type of decisions made and the methods they used in making decisions. This research was also concerned with each team's key decision-making process (the types, timing and number of decisions) with respect to the software development.

Hartley (1997) suggests that groups can adopt different strategies for problem solving and decision-making. He classifies these into two main categories: adopting new procedures or changing their decision on making rules. Hartley's (1997) also describes 7 methods that teams use for decision-making strategies. This research looked at each team's decision-making strategy using Hartley's 7 methods. Chapter 6 outlines Hartley's 7 methods and discusses each group's decision-making process.

3.11.1. Understanding Communication In Group Decision-Making

Poole and Hirokawa (1986) distinguish two ways in which communication enters group decision-making. Communication can be identified as the **medium** of group interaction and therefore the channel for critical functions required for effective group decision-making. Communication regarded as a **medium** is viewed as a tool of social action, which mediates

> *the effects of traits, knowledge, preferences, task characteristics, and scores of other influences on decision-making.*
> *(Poole and Hirokawa, 1986).*

Communication can also be viewed as **constitutive** of group decisions. It is believed to **constitute** decisions in two senses. One is the form and content of decisions, which are worked out through communication. The second is the process of communication, which is seen as the primary means through which social reality (Poole and Hirokawa, 1986) is created and sustained, giving the possibility of decision-making. Studies that view communication as constitutive of group decisions usually employ qualitative methodologies such as participant observation, conversational analysis and critical methods (Chesebro *et al*, 1973).

3.11.2. Identification of Decisions

Borman (1986) believes that communication creates and develops a group culture, which later evolves and interacts with the task dimension to shape the communication process of decision-making. A group's communication therefore can contain more information than just the decision-making process. Groups do more than simply make decisions. Groups are involved in many different practices such as their other work and maintaining the emotional and social relationships within and outside of the group. Decisions can be very brief or can extend over numerous meetings. They can involve a few members or they can involve the whole group. In most cases, decisions are distinguishable from other group activities. Decisions involve a series of activities and choices rather than a universal choice. Simon (1976) observes

> *every choice is embedded in a means-ends hierarchy in which it serves both as a means for a larger choice and as the end of more restricted choices.*

3.11.3. Decision-Making in Problem-Solving Tasks

> *Human problem-solving can be divided into two operations: the definition and representation of the problem (task), and the development of a solution based on the representation... Of the two, task representation is more critical, since it sets the parameters for solution development*
> *(Poole and Doelger, 1986).*

In group decision-making, the **task** involves dealing with a problem or opportunity and managing its process to accomplish the decision. The **task representation** is the way the individual sees or represents the problem. A simplistic example might be to give a group of individuals the task of building a boat. Each individual will have a different task representation. One might see the boat to be a sailing boat and another might see the boat to be a fishing boat. Poole terms the managing process as the **decision logic** - a theory of how the group should make a decision. This entails a strategy for decision-making, which can be a sequence of steps necessary to make a decision (Poole and Doelger, 1986) or a method such as decision by authority without discussion (Hartley, 1997).

Not all groups consciously adopt a decision-making strategy. If they have a strategy, it is usually by default due to the group's structure or make-up, or they happen to fall into it by accident. Even with a decision-making strategy, groups can run into difficulty. Poole and Doelger (1986) outline three possible complications.

- There are individual and collective task representations. Each group member may hold a different task representation, which are implicit theories about the decision. The individual task representation would guide his or her conduct in the group discussion. There is also a collective task representation held by several or all members and is worked out during the group's communication and interaction. Ideally, all team members will have the same task representation, however it is more likely that there are more than one task representations within a group.

- The second possible complication assumes that not all task representations are clear or complete at all points in a discussion. Collective representations are discussed publicly and are often only partially worked out and they will then suffer from lack of clarity. Individual representations can also suffer from lack of clarity, as they are not always discussed publicly.

- The third possible complication is that both the individual and collective representations may change over time. New information or problems discovered during the decision process can also be a source of change.

Taking into account the possible complications, Poole and Doelger (1986) have developed a model of the generation of decision paths.

> *Group decision activities are guided by task representations. The collective task representation, which governs the decision path, is constituted through the interaction of members, each guided by an individual task representation...Collective representations are publicly developed as the group attempts to complete present activities, plan future activities, or formulate what it has done up to the present (Poole and Doelger, 1986).*

The complexity, definition or representation of a group's task and its solution development can help or hinder in the group's decision-making process and therefore its effectiveness (Hartley, 1997). Several decision structures and models have been developed through previous studies. The appropriate decision structure for a particular group to depend on contingency factors, which in turn may complicate the path of groups attempting to follow a set decision structure.

3.12. Other Relevant Issues Considered in this Research

Individual and Team Goals

- According to Thelen (1968), teams need to have publicly stated and shared goals. This helps the teams to identify their work as an activity where the members are seen as 'pulling together' and therefore having a feeling of co-operation.

- Weldon and Weingart (1993) and Mills (1967) distinguish between team goals and individual goals. Although working as part of a team, each individual member can have an individual goal which may be the same or different from the team goal.

- Goals are seen as important guides of human actions. People who are goal-directed tend to direct their behaviour towards attaining the specified goal while ignoring activities that are not relevant to the goal. This leads to the belief that there is a correlation between goal commitment and performance. This research investigated individual and team goals in Chapter 8.

Team Size

- Another factor considered relevant in team performance is the size of the team. Hartley (1997) disputes the idea that two people can act as a team. He states that a pair of people is called a dyad and the interaction occurring in a dyad is very different to the interaction occurring in a group. Psathas (1960) posits that as the size of the team increases the division of work shifts so that larger portions are given to the 'highest ranking initiator' and smaller proportions to other members. The team size of 5-6 students for this research was set by the Runestone Project teachers. This research took into account the effect, if any, the team size has on performance. Chapter 8 looks at each team's profile, which also looks at the team size.

Project Duration

- The amount of time allowed for completion of the project affects the distribution and quality of the project itself (Mills, 1967; McGrath, 1990). McGrath (1990) suggests that groups, which are given an ample amount of time to carry out a project, use up all available time. These groups however, may spend the time paying more attention to evaluating tasks and therefore deliver a higher quality product than one produced in a shorter amount of time. McGrath's correlation between time and quality is interesting and can be valid, however, a deciding factor in this correlation is how the group decides to use the time. This is not a direct correlation but one dependant on other factors. Chapter 6 investigates the decision-making process along the project's timeline.

3.13. Chapter Summary

This chapter has placed this study in the context of collaborative work, in the area of Computer Science. The aim of this research was to investigate how student teams effectively build software at a distance and what characterises high performance in terms of software development in remote student teams.

In order to achieve this aim, issues such as team structure, team goals, group development, decision-making, group interaction and communication must be researched for a better understanding of their definition and context within this research.

Three general areas were identified as being of particular relevance to this research. Previous models were used as guides in the development of categories (Chapter 4) and further analyses carried out throughout this research.

- The first area was in software development. Research showed the Waterfall Model reflected in the structure of the course and familiar with most of the students. This model was used in identifying each team's software development process (Chapter 7).
- The second area was in group interaction. Bales and Danziger's interaction analysis methods were used as guides in the development of a set of categories (Chapter 4). The new set of categories was developed to analyse the software development task within each remote team's communication (Chapter 5).
- The third area was that of group development. Poole's Multiple Sequence Model was found to complement the iteration in the Waterfall Model of software development. This model was used to analyse each team's group development process (Chapter 8).

As a result of reviewing the literature, a research plan was devised. This involved the use of categories developed for this research. The communication was examined to investigate what was happening within the group (Chapter 5). Interactions were also compared with the decision-making process (Chapter 6), the software development process (Chapter 7) and the group development process (Chapter 8).

Chapter 4

Study Methodology

4.1. Introduction

This chapter describes the data collected during the 2000 presentation of the Runestone project (described in Chapter 2) and discusses the research process from data collection to analysis. Drawing on the entire record of electronic communication for 8 groups, the study used inductive analysis techniques to characterise communication, decision making and the process of software development. Also, the analysis (to be reported in detail in later chapters) examined inter-relations among these factors and high- or low-performance. This chapter describes the derivation, validation, and application of the protocol analysis scheme. It further identifies the team performance criteria and describes the creation of team profiles.

4.2. Data Collected from Runestone 2000

The data collected during the presentation of Runestone in 2000 consists of background questionnaires, project logs, interval logs (discussed later), student email archives, Internet Relay Chat (IRC) archives, web pages, peer evaluation and tutor interviews. Figure 4.1 gives a pictorial overview of the data and how it was handled, showing both the sources and how they were manipulated. The following sections describe in more detail the selection of teams for scrutiny and the data collected.

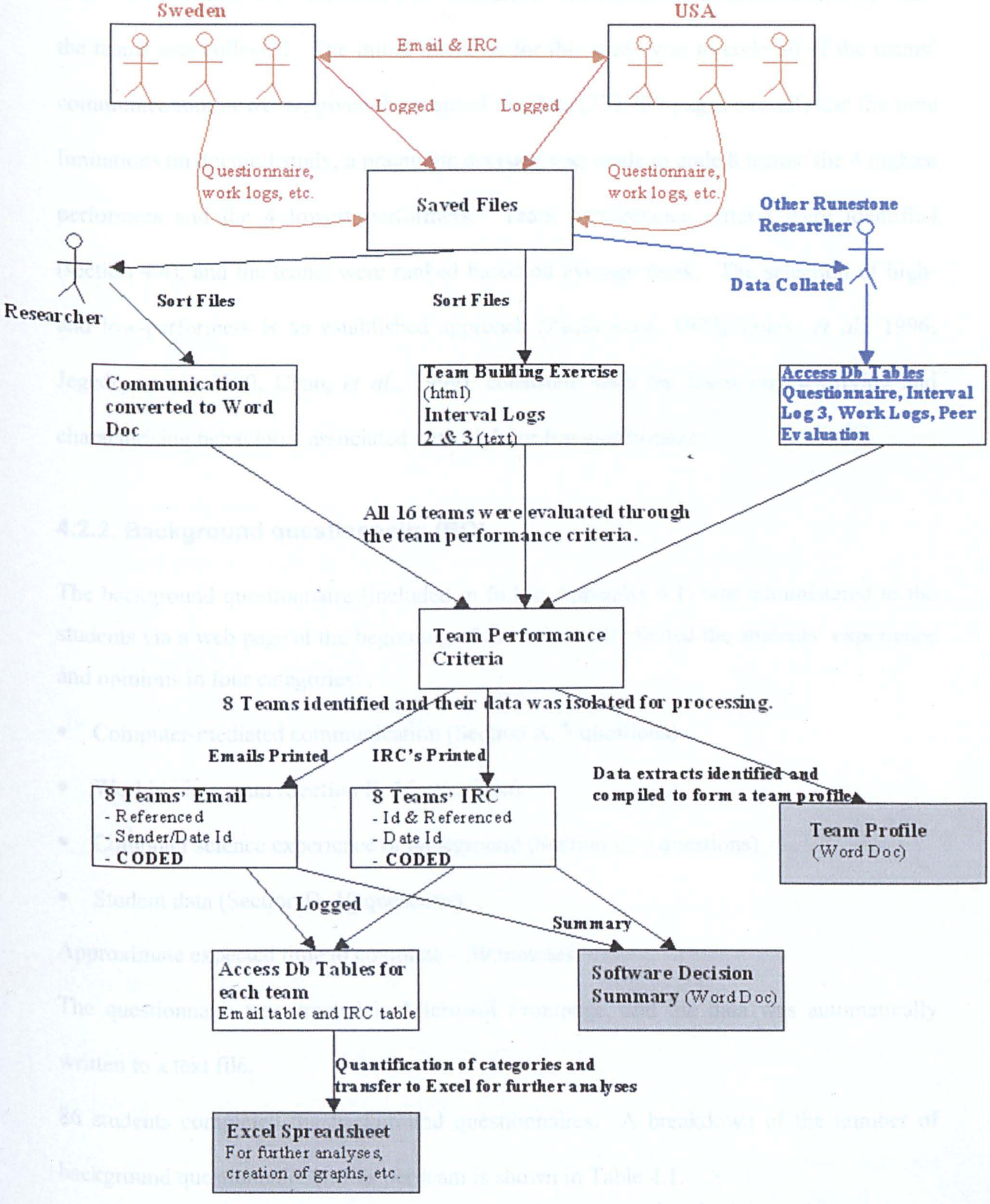

Figure 4.1 - Research Process Overview from Data Collection to Analyses

4.2.1. Selection of teams

As described in Chapter 2, the 2000 Runestone project involved 96 students (47 Swedes and 46 Americans) in 16 teams of 5 or 6 students. All electronic communication by all of the teams was collected. The initial intention for this study was to code all of the teams' communication; however, given the scale of the data (372,359 pages overall) and the time limitations on doctoral study, a pragmatic decision was made to code 8 teams: the 4 highest performers and the 4 lowest performers. Team performance criteria were identified (section 4.4), and the teams were ranked based on average mark. The selection of high- and low-performers is an established approach (Zuckerman, 1979; Truex, *et al.*, 1996; Jegede, *et al.*, 1999; Chan, *et al.*, 1999), consistent with the focus on identifying and characterising behaviours associated with high- or low-performance.

4.2.2. Background questionnaire (BQ)

The background questionnaire (included in full in Appendix 4.1) was administered to the students via a web page at the beginning of the course. It elicited the students' experience and opinions in four categories:

- Computer-mediated communication (Section A, 3 questions)
- Working in a team (Section B, 16 questions)
- Computer science experience or background (Section C, 3 questions)
- Student data (Section D, 10 questions)

Approximate expected time to complete – 30 minutes

The questionnaire was created in Microsoft Frontpage, and the data was automatically written to a text file.

86 students completed the background questionnaires. A breakdown of the number of background questionnaire entries per team is shown in Table 4.1.

4.2.3. Project Logs (PL)

Students were asked to make an entry in an electronic project log (see Appendix 4.2) for each period of time they spent working on the project, regardless of whether it was group or individual work. The project log was intended to capture the amount of time students spent on the project. It was recommended that the logs be completed 'on the spot', however, it was accepted that entries could be completed from memory of previous work. Information required by the logs included:

- Month and day
- Type of work
- Communication medium
- Duration (hours/minutes)
- Brief description of work
- Current work or previous work (i.e., contemporaneous or post-hoc entry)
- Name
- Team number

Approximate expected time to complete – 1 minute per entry

The log was maintained on a web page, created in Microsoft Frontpage, and the data was automatically written to a text file. 1004 entries were completed over all the project logs. A breakdown of the number of project log entries per team is shown in Table 4.1.

4.2.4. Interval Logs (IL)

The students were asked to complete three electronic journals (known as interval logs [IL]) at intervals through the course (examples in Appendix 4.3). These interval logs (IL) were intended to elicit students' reports of their activities and students' perceptions and opinions of their experiences. Each journal gave the students guidance in the form of a list of questions the students were invited to answer. A breakdown of the number of interval log entries per team is shown in Table 4.1.

Interval Log 1 was made available for completion at the beginning of the course. It included guidance questions on:

- Roles
- Completed activities (to date)
- Communication
- Initial impressions

51 students completed Interval Log 1.

Interval Log 2 was made available to the students in the middle of the course. Guidance questions concerned:

- Completed activities (technical)
- Completed activities (team process)
- Class matters

37 students completed Interval Log 2. Interval Logs 1 and 2 were created in Microsoft Frontpage, and the data was automatically written to text files.

Interval Log 3 was offered at the end of the project. This gave more defined questions about the project and the student's involvement in it. Questions were organised into the following sections:

- Individual outcomes (4 questions)
- Team outcomes (6 questions)
- Technical learning outcomes (3 questions)
- Advice for the future (4 questions)
- Closing thoughts (1 open question)

Interval Log 3 was given to the students in paper form during class time. It was hoped that the quantity and quality would be higher for this journal than the previous ones. 73 students completed Interval Log 3.

4.2.5. Student Email Archives

Students used email for regular correspondence between team members and their teachers. All email communication was conducted in English and was archived. The number of emails for the high- and low-performing groups only is reported in Table 4.1 below.

4.2.6. Internet Relay Chat (IRC)

Students used Internet Relay Chat (IRC) for regular meetings and chats. All IRC communication was conducted in English and was archived. The number of emails for the high- and low-performing groups only is reported in Table 4.1 below.

4.2.7. Web Pages

Students used web pages to introduce themselves to the rest of the team and to share project documents. The team building exercise was a set of question that one person in the team would ask another person via an interview session. The answers to this questions were then placed on the team web pages. This was designed so that the team members would get to know each other. All web interactions were conducted in English and were archived. The teams that produced web pages are indicated in Table 4.1.

Table 4.1 - Runestone 2000 Data Collection Breakdown per Team

Team No.	No. Mem	BQ entries	PL entries	IL1 entries	IL2 entries	IL3 entries	No. of emails	No.of IRC Sessions	Web Page
T1	6	6	65	2	1	4	93	68	X
T2	6	6	80	3	1	4	N/A	N/A	X
T3	6	5	54	3	1	6	N/A	N/A	X
T4	5	4	56	2	2	5	115	4	X
T5	6	5	12	4	2	5	N/A	N/A	X
T6	5	5	18	2	2	5	68	20	X
T7	6	6	66	4	3	4	N/A	N/A	X
T8	6	6	111	6	5	5	N/A	N/A	X
T9	6	6	24	3	1	4	97	32	X
T10	5	5	70	4	3	5	247	7	X
T11	6	5	56	3	3	5	136	46	X
T12	6	4	41	2	2	6	N/A	N/A	X
T13	6	6	91	4	2	3	135	17	X
T14	6	5	112	3	3	4	177	27	X
T15	6	6	56	3	4	5	N/A	N/A	X
T16	6	6	92	3	2	3	N/A	N/A	X

Key:
No. Mem = Number of members in relevant team
BQ entries = Background Questionnaire entries
PL entries = Project Log entries
IL1 entries = Interval Log 1 entries
IL2 entries = Interval Log 2 entries
IL3 entries = Interval Log 3 entries

4.2.8. Peer Evaluation

Students were given peer evaluation forms on paper during class time at the end of the project. Students were asked to evaluate their own and their peers' performance throughout the project (5 questions). They were also asked to distribute 100 points among members of the team in proportion to each individual's contribution to the project.

4.2.9. Teacher Interviews

The course teachers were interviewed informally via face-to-face discussions, telephone conversations, and email questions. These interviews were intended to elicit teachers' opinions, impressions, and ideas about course progress, how teams were functioning (or not), and influencing factors. The interviews did not follow a set script but were rather dictated by the information required at the time of the interview. All email interviews were archived and notes were taken of all telephone and face-to-face interviews.

4.3. Mechanics of data collection and handling

Email and IRC communication were logged by the students themselves. The questionnaire, project work logs, third interval log and peer evaluation were collated into tables in an Access database by another Runestone researcher. The first two interval logs and the team building exercise were stored in their original text and html formats, respectively.

All teams logged their email and IRC communication using their own personal systems. All communication was recorded and ultimately recovered, although some of the IRC logs were stored in obscure places and required tracking down. The completeness of the collection was verified by cross-checking email references to IRC meetings against IRC logs, because teams arranged IRC times in advance via email. This made the collection and sorting of this data an interesting and sometimes frustrating task. It was noted that the teams that were well organised and sorted their information in clear, well-labelled files were also teams who performed well. The opposite was true for teams that did not perform well.

4.3.1. Processing of Data

The communication for all 16 teams was saved in various formats. For purposes of consistency, all email and IRC communication was converted into Word 97 format and a uniform page layout was applied. As the page layout was the same for all 16 teams' communication, the size of the files was measured in numbers of pages. Interactions or sessions differed in size and therefore would not have been a good representation.

Some teams had many more pages than others because the communication was mixed with other data such as digital pictures converted to textual symbols, some code, and in some cases instructions for the game, which was coded. The email and IRC communication for each team were isolated for this study. This process involved examination of each page, leaving no doubt that the communication data was complete.

In some cases, there was duplication of communication when two different team members, each logging an IRC, entered or left the meeting at different points. The two logs covered the communication for the same meeting, but depending on the point of entry, one student's log had more or different communication than the other student's. Duplication was eliminated by review of all the communication and merging of the duplicates, so that the communication covered the entire meeting, regardless of late arrivals or early exits.

Table 4.2 shows a data profile of each team's communication. It shows which teams appeared to have 'missing' IRCs (i.e., had obscurely stored logs that were later recovered), the logs' size in page numbers, which teams had duplicates, and which communications were mixed with other data (until the communications were separated out by the researcher).

Table 4.2 - Data Profile of Each Team's Communication

Team No.	Missing IRC	Total Page No.	Mixed Data	Duplication
1		260		
2	X	297	X	
3		280	X	
4		152	X	X
5	X	480	X	
6	X	1646	X	
7		622	X	X
8		1013	X	X
9	X	894	X	X
10		337		
11	X	884	X	
12		218	X	X
13		684	X	
14	X	362,044	X	
15	X	271	X	
16		2277	X	
Totals	7 teams	372,359 pages	14 teams	5 teams

4.4. Team Performance Criteria

As this study sought characteristics of high- and low-performing teams, it was important to identify team performance. Team performance was calculated with the aid of the two teachers involved in the Runestone Project during 2000. As each team consisted of members from each country, the teachers divided their responsibilities by odd- and even-numbered teams. The US teacher took charge of the odd-numbered teams and the Swedish teacher took the even-numbered teams.

4.4.1. Assignment of milestone marks

Marks were given on a scale of 0-5, with 5 being the highest mark. The course structure consisted of 8 set deliverables marked by 8 specific milestones during the 10-week course duration. At the end of each milestone, the teams were required to make a presentation.

Each team member took a turn at presenting. Two marks for each milestone were given: one to the team as a whole, and one to the individual who undertook the presentation.

Although the teachers were consistent in how they assigned the *individual* milestone mark, they calculated the *team* milestone marks slightly differently. The Swedish teacher gave separate marks for team performance and team progress for each milestone; he then averaged these two marks to give a total team milestone mark. The US teacher gave one mark for each milestone, taking into account both the team performance and the team progress. This study used an average of all milestone marks (1-8), keeping note of how they were generated by the teachers. This then gave each team one average mark for all 8 milestones.

4.4.2. Assignment of final marks to individuals

Final marks given to the individual students were calculated by taking into account the following:

- Individual milestone mark - given to the milestone presenter (counted as 20%).
- Team milestone mark - given to the team at the end of the milestone (8 in total – counted as 40%)
- Final functionality mark - given to the team at the end of the project (counted as 20%).
- Final presentation mark - given to the team after the final presentation (presented by all team members – counted as 10%).
- Peer/teacher evaluation - affects individual's final marks +/- one grade level. The teacher evaluation was a final evaluation that the teachers gave taking into account each team's performance throughout the project. Peer evaluation is outlined in section 4.2.8.
- Runestone participation - percentage given to individual for participation in project (counted as 10%).

Prior to the course beginning, the teachers discussed the criteria and came to an understanding about how the criteria would be applied. A detailed criteria for each component identified above was published on the course web site so that the students would know what was expected of them. For assessment purposes, each teacher took on have the teams. One teacher took the odd numbered teams and the other took the even numbered teams. At each milestone, the team and the individual giving the report was given a mark and written feedback on what they had done right or wrong. While doing research for this study, the researcher had detailed conversations with both teachers regarding the assessment criteria and the marking process. The researcher was convinced that the marking was consistent and accurate Further information on assessment is found in Chapter 2.

4.4.3. Calculation of the Team Average Mark

As this study was concerned with *team* performance, it used an average of the *team marks* to rank the teams. The **Team Average Mark (TAM)** refers to the arithmetic mean of:

Team Milestone Mark (overall average of milestones 1-8)

Team Final Presentation Mark

Team Final Functionality Mark

The teams were ranked by the TAM from highest to lowest as per Table 4.3 below.

Table 4.3 - Team Average Mark Ranking

Team Number	Team Ave Mark (TAM)
J	4.97
M	4.89
F	4.86
A	4.83
H	4.81
E	4.72
P	4.44
G	4.28
C	4.22
O	4.11
B	4.1
L	3.92
N	3.8
K	3.67
I	3.56
D	3.06

The team numbers have been changed in Table 4.3 above in order to protect their anonymity. The top four teams were identified as the high performers, and the bottom 4 teams as the low performers. The high performing teams will be identified as H1, H2, H3 and H4 and the low performing teams will be identified as L1, L2, L3 and L4. Once these teams were identified, the coding process (section 4.6) began.

4.5. Coding of Data

4.5.1. Coding overview

A coding scheme of 12 top-level categories, each with sub-categories, was developed inductively and iteratively to identify communication types (section 4.5.2). The coding scheme was validated systematically (section 4.5.4). These categories were used to code all emails and IRC's of the 8 teams identified as low- and high-performing. When the coding was completed for each team, the coded phrases were logged (section 4.7). The coding produced data that could be quantified (as numbers of occurrences for each category) for analysis. In addition, the *process* of coding, which required reading and re-reading the communications, enabled a systematic, qualitative analysis of the communication data to produce the team profile (section 4.8) and the summary of each team's key decision-making process with respect to the software development.

Figure 4.1 shows a visual representation of the process, from the generation of the data to its analysis. The different coloured figures and arrows show the actions of the different *actors* within this process. Red represents the actions of students involved in the Runestone Project. Blue depicts the actions of the Runestone researcher, and black shows the steps taken for this study. The shaded boxes represent the final step in each process line.

4.5.2. Category derivation

The literature on computer-supported collaborative work includes a number of studies which have investigated team interactions and which have developed different ways of categorising such interactions. Two studies of particular interest to this investigation were Bales's (and Strodtbeck, 1951) Interaction Process Analysis (IPA) and Danziger's (1976) coding scheme, each of which provided a framework for categorising interactions.

Bales's interaction model incorporates many of the phases previously identified within the group development process models and classifies its categories as either *task* or *socially* oriented. Danziger's model was developed with the idea that classification of verbal utterances should be based on the *role* the utterances play in the social interaction within which they occur (Danziger, 1976). Danziger's and Bales's category models are summarised in Appendix 4.4.

Both Bales's (IPA) and Danziger's coding schemes were used as general models. Both developed their categorisation frameworks in the broader context of social psychology enquiry, and, although they would have been useful for identifying the *group* development process, they did not seem suitable for identifying the *software* development process and the key software decisions. Hence, both models were taken into account when deriving the top-level categories for this study. But, because this study needed to take into account the remote environment, the task specifics, and the duration and distinctiveness of the Runestone Project, it was necessary to develop additional categories that were more specific to the problem at hand.

Initial top-level categories were developed using the structure and type of categories from Danziger and Bales's group development models. The Waterfall and Poole software development models were used as guides (See Appendix 4.4). Each communication log was read and careful attention was placed on what was happening in the group. The communication was classified into categories such as those identified in Danziger and Bales's models. The initial stage of classification was social or task. The communication showed that conversation within the group was more specific, for example task communication could be planning work or making decisions. These classifications became a category when there were several instances of it. Social communication was also noted and this was also classified in different categories such as getting to know and humour. The communication logs were read through twice to make sure that all the phrases were classified under a general category. A phrase was considered as a sentence or sentences that discussed the same issue. These general categories then became the top-level categories. This literature-based scheme was applied to data from the 1999 presentation of Runestone and its adequacy for characterising the data was evaluated.

It was recognised that although the communication could be classified under a general heading such as planning work, the 'actions' described were more specific than the top-level categories previously developed. A finer granularity of categories was necessary, and sub-categories were developed, through iterative inductive analysis. For example, a particular phrase, for example, *...have you done anything on the client?,* was categorised as 'planning work' (C1). However, aspects of the phrase showed that it could be 'identifying tasks' or 'requesting update of work' or a number of other actions. This meant that different instances of a phrase had different categorisations, depending on their contexts.

As the categories and sub-categories were being refined through repeated application and analysis of the mis-fits, each category and subcategory was defined explicitly and illustrated with an exemplar, in order to facilitate consistent interpretation. During its development, the coding scheme was tested and refined by this study's researcher. As necessary, an independent coder was consulted to assess the comprehensibility and applicability of the category definitions. Although this study concentrated on data produced by the 2000 presentation of the Runestone Project, the coding scheme was developed using data from the 1999 presentation, especially from Team 4.

Once the coding scheme was stable, it was validated (explained in section 4.5.4) by two independent coders using data from other teams from Runestone 2000. The category framework derived for this study is presented in Figure 4.2 below. The definitions and exemplars of the category framework are presented in Appendix 4.5.

Figure 4.2 - Top-Level and Sub-Level Categories

C1-PLANNING WORK	C2-PLANNING ADMIN	C3 - DECISIONS	C4 - ROLES
1-Structure project	1-Meetings when	1-Use of Equipment/language	1-Show (recognise) leadership
2-Project requirements	2-Meetings how (IRC, NetMeeting...)	2-Use of method/format	2-Show technical knowledge
3-Identification of tasks/Design	3-Meeting agreements	3-Work to begin	3-Self-expressed expertise
4-Allocation of tasks	4-Sub group meetings	4-Seek confirmation on decision	4-Colleague-expressed expertise
5-Task value/Importance	5-Plans/agenda for meeting	5-Request for vote on decision	5-Declare lack of knowledge
6-Prioritise tasks	6-Structuring of meeting	6-Vote given	6-Show reluctance to take on a task
7-Proj milestones/deadlines	7-Meeting log		7-Show willingness to share work/ideas
8-Completed work	8-Sub-Meeting where (physical)		8-Show withholding of work/ideas
9-Proposal for work plan	9-Tutor Feedback/Intervention		9-Ask for tutor advice or outside sources
10-Request for work update	10-Absent members		10-Show conf/frustration at course admin
11-Work update given			
C5 - CONFLICT	**C6-SOCIAL/GET TO KNOW**	**C7 - HUMOUR**	**C8-GRAPHICAL EXPRESSIONS**
1-Initiating	1-Volunteering information	1-Initiate	1-Friendly/Greetings
2-Challenge	2-Asking for information	2-Respond	2-Defuse (poss.) conflict
3-Resolution of	3-Initiage greet/farewell/apology	3-To defuse a situation	3-Confusion
4-Reasoning	4-Replying to greetings/info/apology	4-Local to country/area	4-Surprise
5-Misunderstanding	5-Validation that work is correct		5-Humour
6-Avoid	6-View/Id comm media/dist as obstacle		6-Emphasis of expression (CAPS/!!)
7-Suggest compromise	7-Ignore comm media/distance		7-Show disapproval/unhappiness/sympathy
8-Cautious approach	8-Encouragement		
9-Dismissive	9-Show gratitude		
10-Defuse situation			
C9 - IDEAS	**C10 - IDENTIFICATION**	**C11 - TASK/WORK SPECIFIC**	**C12 - GOALS**
1-Initiate	1-With whole group	1-Suggest changes	1-Team goals
2-Challenge	2-With sub group	2-Justify request/propose for change	2-Personal goals
3-Request ideas/opinions	3-As individual	3-Propose (method) of work	
4-Offer advice/instructions/info		4-Critique work	
5-Critique		5-Verify/understanding	
6-Support idea		6-Challenge new proposal	
7-Reply to request		7-Request clarification	
		8-Clarify tasks/work	
		9-Recognise problem	
		10-Resolve problem	
		11-Identify lack of resources	
		12-Test planning or carried out	

In summary, an initial coding scheme was derived from the literature. This scheme was refined and extended through iterative application, coupled with inductive analysis. Through this process, it was established that the data could feasibly be coded into specific categories, which would help in the identification of both interaction types and software development processes. Once the coding scheme, encompassing 12 top-level categories each with sub-categories, was considered stable, the definitions and exemplars for each category and sub-category (Appendix 4.5) were augmented with coding guidelines (Figure 4.3 below). The next section describes how the coding scheme was validated.

Coding Guidelines

1. The term 'coding' is defined here as assigning a category and sub-category to a line of textual communication known here as a phrase.

2. A coded phrase is considered to be part of a sentence, a whole sentence or sentences that relate to the same category and sub-category. A line of text that has been assigned a category and sub-category is considered one phrase of that category and sub-category regardless of its length and sentence structure, until the line of text changes in context. It then relates to a different category and sub-category therefore signalling the beginning of a new phrase. Or until that line of text is concluded by the individual 'talking' in the case of an IRC (Internet Relay Chat) or in the case of an email, where there is no more text.

3. Familiarise yourself with the categories and sub-categories by looking at the examples provided with the category table.

4. Be aware of who and how many people there are in each team. If the communication you are coding is an email, be aware of who the sender is. If the communication is an IRC, know who each of the 'speakers' are in relation to the team members in case there are nicknames used instead of their actual names.

5. Phrases are context driven so it is important to the coding to remember the line of thought throughout the whole communication.

6. Read each individual's comments and decide which top-level category it belongs to. For example, is the general idea discussing the planning of a meeting (C2), planning/assigning/designing work (C1), discussing ideas (C9), talking specifically about the work undertaken (C11), socialising (C6) or telling jokes, using humour (C7)?

7. Once you have decided what top-level category is being communicated, look at specific actions within that category and match it to a sub-category within the chosen top-level category. For example, if the communication involves planning admin (C2), is the specific action planning a meeting involving the whole team (2.1) or part of the team (2.4)? Is the specific action discussing the media to be used in the meeting (2.2) or if a sub-group meeting, where are they going to meet (2.8)? Are they communicating what will be in the agenda (2.5) or how to structure the meeting (2.6)?

8. It is important to note that phrases can cover more than one category and sub-category. In a communication that is planning a meeting of the whole team (2.1), they could also be planning to meet via IRC or email (2.2) and could discuss what is to be covered in that meeting (2.5).

9. Multiple categories in each phrase do not have to stay within the same top level/sub-category. Phrases can relate to more than one different category. For example, in a communication where work is being planned (C1), there could also be sharing of ideas (C9) and also use of graphical expressions (C8).

10. When you have decided on the category and sub-category, place the numerical representation of the top-level category (1-12) next to the relevant phrase, followed by a full stop and the numerical representation of the sub-category within the relevant top-level category as in 2.1. Use a pencil to allow revisiting without damaging the text.

Figure 4.3 - Coding Guidelines

4.5.3. External 'reality check'

During October 2001, once the coding scheme had stabilised, I visited Prof. Gary Olson and Prof. Judith Olson at the University of Michigan, Ann Arbor. The Olsons are eminent researchers in team-based software development; their work on analysis of interaction during software design (Olson and Olson, 1990; Olson, *et al*, 1992; Olson and Teasley, 1996; Covi, *et al*, 1998; Teasley, *et al*, 2000) is seminal. Their laboratory draws on expertise in cognitive psychology, social psychology, and software engineering. During my visit, the Olsons reviewed critically and in detail the research plan for this study, including the analysis plans. We discussed the issues of categorisation, and safeguards during qualitative and quantitative analysis. Although they made suggestions at the detail level, the Olsons were satisfied with the coding scheme and analysis plans, providing an expert, external 'reality check' for the work.

4.5.4. Testing for Validity

Validation of the categories was conducted by two independent coders not otherwise associated with this research. Assessment of validity requires inspectors with expert domain knowledge. For this study, the domains were software development, group work and remote communication. Both independent coders had extensive professional experience in software development, remote work and group work in both industry and academia, as both teachers/trainers and group members.

Each worked independently to apply the coding scheme, as documented, to code data from other teams (middle-performers) in the 2000 presentation of Runestone. Because the categorisation of phrases was context dependent, the coders were given access to all communication for the team being coded.

There are several ways of assessing an instrument's validity – its ability to capture what it was intended to capture (Coolican, H., 1999, Sirkin, 1995). The purpose of the coding scheme was to categorise (qualify) types of communication used by a team developing software. Hence the validation focussed on **face validity** and **content validity**.

Assessing **face validity** requires inspection of the contents of the instrument, in this case the categories in the coding scheme, to see whether it measures or captures what was intended. The coding scheme was deemed valid by the independent coders, because it identified usable, comprehensively, and satisfactorily the types of communication observed in the team interactions.

Assessing **content validity** *"based on logic and expertise"* (Sirkin, 1995), requires evaluation of the content of the coding scheme to ensure that it was *representative* of the area being studied. The coding scheme was deemed valid by the independent coders, because it covered the areas of remote working, group working and software development with suitable and meaningful categories. It is important to note that the independent coders only coded samples for testing. All the data for this research was coded by the researcher alone.

4.5.5. Testing for Reliability

The reliability of the coding scheme, its "accuracy in terms of producing the same results on different occasions" and with different coders (Coolican, H., 1999), was assessed using a test-retest strategy in two parts:

i) one independent coder coding two different data sets. First data set taken from Runestone 1999 and second data set taken from Runestone 2000 (same person, different times: IC-1 Test 1 and IC-1 Test 2), and

ii) two independent coders coding the same data. The second data set from Runestone 2000 (same data, different people: IC-1 Test 2 and IC-2 Test 2)

The first independent coder (IC-1) was asked to code the first data set (from Runestone 1999) which consisted of two emails and two IRCs. Two independent coders (IC-1-same person that coded first test and IC-2) were asked to code the second data set (from Runestone 2000) with consisted of two emails and two IRCs. Coders were given the coding scheme, including definitions and exemplars (see Appendix 4.5), and guidelines on coding (Figure 4.3). They were also given access to the relevant teams' entire communication. IC-1 received a face-to-face explanation of how to carry out the validation. IC-2 received instructions over the phone, reinforced by written guidelines sent via email.

The sample emails and IRC's were previously coded by the researcher to create a **master copy (MC)**. The number of coded phrases was totalled at the end of each communication in the master copy. The number of coded phrases in each independently-coded email and IRC was also totalled then compared to the master copy total.

As this was a subjective exercise, it was important for the researcher to understand why there were differences. In some cases, the reason was an oversight of phrases by the IC or the researcher where a phrase was not coded in one copy but coded correctly in another. Another reason was due to a misunderstanding or lack of understanding of the content. This was cleared up after discussion and usually led to an agreement on both parts. The unresolved discrepancies were reflected in the marking scheme as explained below and are reported in Table 4.4, column 5.

In order to show the percentage agreement or disagreement between the independent coders' copies and the master copy, a marking scheme was devised by this researcher. A 'point' was assigned to each phrase where a disagreement still occurred after discussion. Because there were top-levels and sub-levels, it was possible that only the sub-level showed disagreement but not the top-level. A full (one) 'point' was assigned when the disagreement occurred at the top-level, and half a 'point' when the disagreement occurred at the low-level but the top-level was agreed. For example, if the IC assigned a coded phrase a 3.1 category and the MC gave the same phrase a 5.6 category, this would count as 1 point. If the IC assigned a coded phrase a 3.1 category and the MC gave the same phrase a 3.4 category, this would count as ½ point because there was agreement in the top-level (3) but not in the sub-level (.1 as opposed to .4).

For each phrase that was coded differently by the IC, there was discussion between the IC and the researcher and either an agreement or disagreement was recorded. A disagreement resulted in a point being assigned for each disagreement. The following scenarios show the instances where points or half points were assigned.

If it was agreed that the IC was correct then a point was assigned (or half-point depending on if the disagreement was at the top-level or sub-level).

If a phrase was NOT given a category by the IC where there was one in the master copy, discussion was undertaken and one point assigned if the master copy was agreed to be wrong.

If a phrase was given a category by the IC where there was NONE in the master copy, discussion was undertaken and a point assigned if the master copy was agreed to be wrong.

Table 4.4 shows the results of the marking scheme.

- Rows 3-8 show the results for independent coder 1 (IC-1) test 1.
- Rows 11-16 show the results for independent coder1 (IC-1) test 2.
- Rows 19-24 show the results for independent coder2 (IC-2), test1.
- Column 1 shows the type of communication being coded.
- Column 2 shows the total number of phrases in the master copy (MC).
- Column 3 shows the total number of differences before discussion.
- Column 4 shows the total number of agreed phrases after discussion.
- Column 5 shows the total number of disagreed phrases or points after discussion.

- Column 6 shows the total number of matched phrases after the number of disagreements (points) was subtracted from the MC total. This was calculated by subtracting the number of disagreed phrases or points (column 5) from the MC total (column 2).

Percentages were calculated for: the differences before discussion (column 3), the number of agreed phrases after discussion (column 4), the number of disagreed phrases after discussion (column 5) and the number of matched phrases after discussion (column 6). These percentages were compared between the independent coders (IC-1 and IC-2) tests and the master copy (MC) and between the IC-1 test and IC-2 test. Coolican (1999) suggests that if the

> "*...sets of scores are* correlated, *to see whether people tend to get the same sort of score on the second occasion. If they do, the test has high reliability. Correlations achieved here would be expected to be at least around 0.75-0.8." p. 152*

As can be seen from Table 4.4 below,

- The range of disagreement before discussion (column 3) was within 8 percentage points.
- The range of agreements after discussion (column 4) was within 12 percentage points.
- The range of disagreement after discussion (column 5) was within 4 percentage points.
- The range for the matched phrases after discussion (column 6) was within 4 percentage points.

The percentage results compared between the IC tests and the MC and IC-1 and IC-2 were similar with the largest range at 12 percentage points. The test results for the differences or disagreements before discussion (column 3) were between 18% - 26%. The agreements before discussion were therefore between 74% (100%-26%) and 82% (100%-18%). The test results for the 'matched phrases' (column 6) were above 90% agreement after discussion

Although there were differences in the percentages between each test, the differences were minimal. Looking at the results for IC-1's test 1 and test 2, there was a 3.5 percentage points drop in the matched phrases (column 6). IC-1's matched phrase result for test 1 was only a 0.1 percentage points difference from IC-2's matched phrase result. According to the independent coders a familiarity with the categories and the context of the communication was helpful with the coding scheme.

As IC-2 stated,

> *the classification exercise certainly got easier the more I completed.*

These similarities between the results of each of the tests suggested that the set of categories developed for this research was reliable as a coding scheme.

Table 4.4 - Test-Retest Reliability Results

First Test for Independent Coder 1 (IC-1)					
Type	**MC Test 1 Totals**	**IC-1 T1 Total differences**	**IC-1 T1 # of agreed phrases**	**IC-1 T1 # of disagreed phrases or points**	**IC-1 T1 # of matched phrases after agreement**
Email	**3**	0	0	0	3
Email	**4**	0	0	0	4
IRC	**123**	21	14	7	116
IRC	**149**	54	44.5	9.5	139.5
Total	**279**	**75**	**58.5**	**16.5**	**262.5**
% of Total	**Total**	**26.9%**	**21%**	**5.9%**	**94.1%**
Second Test for Independent Coder 1 (IC-1)					
Type	**MC Test 2 Totals**	**IC-1 T2 Total differences**	**IC-1 T2 # of agreed phrases**	**IC-1 T2 # of disagreed phrases or points**	**IC-1 T2 # of matched phrases after agreement**
Email	**8**	0	0	0	8
Email	**7**	0	0	0	7
IRC	**198**	42	21.5	20.5	177.5
IRC	**27**	3	1	2	25
Total	**240**	**45**	**22.5**	**22.5**	**217.5**
% of Total	**Total**	**18.8%**	**9.4%**	**9.4%**	**90.6%**
First Test for Independent Coder 2 (IC-2)					
Type	**MC Test 1 Totals**	**IC-2 T1 Total differences**	**IC-2 T1 # of agreed phrases**	**IC-2 T1 # of disagreed phrases or points**	**IC-2 T1 # of matched phrases after agreement**
Email	**8**	2	1	1	7
Email	**7**	2	2	0	7
IRC	**198**	40	30	10	188
IRC	**27**	10	7	3	24
Total	**240**	**54**	**40**	**14**	**226**
% of Total	**Total**	**22.5%**	**16.7%**	**5.8%**	**94.2%**

The master copy for tests 1, 2, IC-1's test 1 and 2 and IC-2's test can be found in Appendix 4.6.

4.6. Coding Process

After the eight high- and low-performing teams were identified using the team performance criteria (section 4.4), their communication was printed. The coding process followed the guidelines presented earlier (Figure 4.3) and began by identifying phrases in the individual team emails and IRC communications. These phrases were classified under one or more sub-categories. Although sub-categories were assigned to individual phrases, it was recognised that the phrases were context dependent. If the phrases were taken out of context, they would be meaningless and not match the assigned categories.

Wherever possible, phrases were attributed to individuals. Individual team members usually wrote email communications, and phrases could be matched to the team member who wrote it. Although IRC communications involved interactions between several team members, in most cases the writer could be identified. In a few IRC cases however, sub-groups used *nicknames* that represented more than one person. In this case, it was difficult to identify the individual responsible for particular phrases. Coding of these phrases was therefore assigned not to an individual member but to a sub-group identified as *US* for the US sub-group or *SW* for the Swedish sub-group.

All the communication for each of the eight teams was coded.

4.7. Logging Process

The phrase **logging** in this study refers to the transfer of coded phrases from paper to a computerised database for purposes of storage, reference, and analysis. An Access database was used, so that tables could be created to hold the information for each team, and queries could be run quickly and easily. IRC's and emails were kept in different tables, to facilitate their identification. Excel was used in the development of graphs, because it is more direct and flexible in creating graphs. Once queries were run in Access, the transfer of data from Access to Excel was straightforward.

The information logged included:

- *Type* - the communication type – E# = Email and number or I# = IRC and number
- *Date* - the date of the actual communication
- *Who* - the initials of the person who wrote it
- *Cat* - the sub-category reference
- *Phrase* - a sample of the phrase, which served as an index to refer back to the actual communication.

Figure 4.4 below shows an example of the Access database table that holds the raw data for Team 13 (Runestone 2000).

TYP	DATE	WHO	CAT	PHRASE
E1	25/01/00	CE	2.9	...the final team assignment have been
E2	26/01/00	SM13	6.3	...hello everyone...
E2	26/01/00	SM13	10.3	...my name is scott ...
E2	26/01/00	SM13	6.3	...quick note to say hello...
E2	26/01/00	SM13	6.6	...they are getting e-mail from this alias...
E2	26/01/00	SM13	2.1	...we can have a quick meeting this
E2	26/01/00	SM13	9.1	...if everyone could email me their
E2	26/01/00	SM13	6.9	...thank you...
E3	27/01/00	LP	2.9	...http://www.csis...
E4	27/01/00	LP	2.9	...sorry...this one should work...
E5	28/01/00	MS13	6.3	...hello...
E5	28/01/00	MS13	10.1	...this is an email to scott...
E5	28/01/00	MS13	2.1	...we suggest that our 1st meeting will take
E5	28/01/00	MS13	9.3	...please let us know as soon as possible...

Figure 4.4 - Logged Data

4.7.1. Data Manipulation for Analyses

This study used qualitative analysis to identify the phrases in the communication and categorise them. This study then used quantitative analysis to relate the number of occurrences in specific categories to factors such as individual, time, or decision making. Data was manipulated via the generation of database queries, which allowed specified data to be segregated, counted, and analysed as an independent factor. Creation of charts from the results of these queries provided a visual aid for analysis. In order to create charts, it was at times necessary to manipulate the query results by generating counts, sums or totals.

4.8. Creation of Team Profiles

A team profile was compiled for each of the eight teams in order to allow comparison of team backgrounds in terms of previous team working experience, computer mediated communication (CMC) experience, computer science (CS) experience, project expectations, and personal information. The team profile is a compilation of excerpts from the background questionnaire, the project work logs, interval logs 1 and 3, peer evaluation, and the team building exercise. The team profile was broken down into 5 sections: personal information, teamwork experience, CMC experience, CS experience, and expectations. Table 4.5 below shows the criteria used in each section, where each was taken from, and how they were calculated to give a team value.

Table 4.5 - Team Profile Guide

TEAM PROFILE GUIDE		
PERSONAL		
CODE	INFORMATION	PROFILE
Team Info	Team No.	Team number
Uni. Files	Gender	Number of males and females
Uni. Files	Age range	Team age range
Team Info	Team size	Numerical value
Sec 3.1 Team Performance	Team grade (Ave.)	Team Average Mark (TAM)
PL (Duration)	Team work hours on project (total overall)	*Answers* given in hrs and min *Profile:* total hours and min.
QSD – Q9	Team work hours outside project (total overall)	*Answers* given in hours. *Profile:* total hours.
QSD – Q6	Team course load (in number of classes)	*Answers* given as list of courses. *Profile:* count total number of courses.
Sec 4 Coded Communication	Team communication in numbers – i.e., Number of emails, IRC etc.	% of email communication vs. % of IRC communication
TEAM WORK EXPERIENCE		
CODE	INFORMATION	PROFILE
QSB – Q3	Team previous experience in team working	*Answers* given as 1-never, 2-at least one, 3-many times. *Profile:* count of answers given for 1, 2, 3.
QSB – Q2	Team percentage of time working alone	*Answers* given in % for time studying alone, with one friend, with a group. *Profile:* Average of 'alone' percentage.
QSB – Q2	Team percentage of time working with other(s)	*Answers* given in % for time studying alone, with one friend, with a group. *Profile:* Average of 'one friend' and 'group' percentage.
QSB – Q6	Team self-classification of roles i.e., all leaders?	*Answers* given as 1-never, 2-some, 3-same, 4-more. *Profile:* Count of types identified as 4 – more than.
PE	Actual team roles	*Answers* given as textual accounts. *Profile:* Team roles as perceived by team, i.e., 1 official leader but others acted as leader.
QSB – Q8 and Q9	Team opinion about working in teams (% of positive and negative)	*Answers* given as textual accounts. *Profile:* Count pos. and neg. adv/disadv as perceived by team without duplication then averages taken of pos. and neg.
QSD – Q1	Team goals	*Answers* given as textual accounts. *Profile:* Count number of goals as perceived by team without duplication.
J1	Team initial impressions of team members.	*Answers* given as textual accounts. *Profile:* Count of pos. and neg. impressions as perceived by team without duplication.
J3 – Q9	Team final impressions of team members.	*Answers* given as textual accounts. *Profile:* Count of pos. and neg. impressions as perceived by team without duplication.
QSB – Q7	Team characteristics.	*Answers* given as 1-first choice of a pair of contrasting characteristics, 2-second choice of a pair of contrasting characteristics. *Profile:* For each pair choice, give count of the greater characteristic chosen.
CMC EXPERIENCE		
CODE	INFORMATION	PROFILE

QSA – Q1	Team overall length of previous use of CMC	*Answers* given as 1-never, 2-at least once, 3-many times. *Profile:* Count of answers given for 1, 2, 3.
QSA – Q2	Team overall range of familiarity with CMC	*Answers* given as range of 1-unfamiliar to 5-familiar. *Profile:* Count of answers given for 1, 2, 3, 4, 5.
J3 – Q6	Team overall opinion on success of CMC work	*Answers* given as range of 1-failure to 10-complete success. *Profile:* Average taken of answers given.
PL	Team percentage of actual use of artificial media	*Answers* given as individual counts of media used. *Profile:* % of artificial media for all team
CS EXPERIENCE		
CODE	INFORMATION	PROFILE
TBE	Team overall CS experience. Known languages	*Answers* given as textual accounts. *Profile:* Count number of languages known by team members.
QSC – Q1 Part 1	Team overall opinion of self-knowledge in CS	*Answers* given as 1-less than, 2-perfect match, 3-better than. Part 1 is your knowledge compared to standards… *Profile:* Count of answers given for 1, 2, 3.
PE	Team overall opinion of contribution of CS	*Answers* given in points assigned to individual members by their peers. *Profile:* Average evaluation for each individual.
EXPECTATIONS		
CODE	INFORMATION	PROFILE
QSD – Q7	Team overall personal expectations	*Answers* given in hours. *Profile:* Total number of hours.
QSD – Q8	Team overall expectations of group work	*Answers* given in % for working alone, with one other person, with your group. *Profile:* Average of 'one other person' and 'group' percentage.
QSC – Q1 Part 3	Team overall expectations of CS	*Answers* given as 1-less than, 2-perfect match, 3-better than. Part 3 is your knowledge…of what you need to complete… *Profile:* Count of answers given for 1, 2, 3.
Code Key:		

QSA, QSB, QSC, QSD = Questionnaire Sections A-D
TBE = Team Building Exercise
PL = Project Log
PE = Peer Evaluation
J1, J2, J3 = Interval Journals) 1, 2, 3

The profiles for each team are presented in Appendix 4.7. Further analysis of each team's profile is discussed in Chapter 8.

4.9. Chapter Summary

This chapter has described the lifecycle of the data used in this study, from its collection, through its coding and logging, to its manipulation through database queries and subsequent quantification. It has described the data in detail, including background questionnaires, project logs, interval logs, student email archives, Internet Relay Chat (IRC) archives, web pages, peer evaluation and tutor interviews. It has described how the eight high- and low-performing teams from the 2000 Runestone presentation were selected for this study using the Team Average Mark (TAM), based on team performance data. Importantly, it has described the development, validation and application of the coding scheme which is at the heart of this study, and it has shown how the coding scheme was informed both by models in the literature and by inductive analysis of data from the 1999 Runestone presentation. It has provided evidence of the coding scheme's validity and reliability. It is on this foundation that the research builds.

The next chapter examines the use of emails and IRCs produced by the students. It discusses the results of significance tests done on the amount of communication in the high and low performing groups, and the organisation of their communication.

Chapter 5

Communication Types and Technology

5.1. Introduction

Previous chapters set the focus of this study and outlined the methodology used. Chapter 4 discussed the communication technology available to the students in the Runestone Project and discussed the formation of a set of categories used for the analysis of communication. This chapter examines the use of emails and IRCs produced by the students. It discusses the results of significance tests done on the amount of communication in the high and low performing groups. The categories developed in Chapter 4 were used to examine the types of communication produced by the teams. The organisation of the communication was also examined for differences in characteristics between the high and low performing groups.

5.2. Analyses Design

The Runestone teams used Internet Relay Chat (IRC) and Email for most of their communication. IRCs were mainly used for regular team meetings and milestone meetings where they reported to the tutors. Email was generally used for co-ordinating meetings, updating of information and ad hoc communication. Although other forms of communication such as Whiteboards, Chat rooms, NetMeeting and Newsgroups were made available to the teams, IRC and Email were the preferred tools. NetMeeting was occasionally used by some of the teams because they were curious about what their counterparts looked like. The NetMeeting sessions usually consisted of socialising and were used jointly with IRC because of the bad audio quality.

<MicUlf> We'll do it via NetMeeting dude
<MicUlf> but we'll also have a backup IRC session
(T9-IRC)

Each team had the responsibility of logging its own communication. There was a possibility that not every piece of communication generated by each team was logged. There was further communication via other channels such as conventional telephone, and verbal or face-to-face communication, which was not logged. The latter types of communication were often re-iterated during group IRC sessions. Hence, it is not believed that this study has in any way suffered or has been affected by the occasional missing communication.

The types, use and amounts of the IRC and Email communication varied greatly from team to team. Although these varied, the communication logged and gathered from each team is believed to be representative of each team's activities, actions, development and processes. The completeness of the collection was verified by cross-checking email references to IRC meetings against IRC logs, because teams arranged IRC times in advance via email.

Analysis of the communication began once each team's communication was categorised and coded (see Chapter 4). This produced a number of coded lines for all the Emails and all the IRC's for each team. Previously, the teams were classified as high or low performing (see Chapter 4). Looking at the number of coded lines for Email, compared with the number of coded lines for IRC for each team, a pattern began to emerge.

Table 5.1 below shows the number and percentages of coded lines for Emails and IRCs for each team. Both the high performing groups and the low performing groups have a higher percentage of IRC to email but the low performing groups have a higher percentage of email (lower proportion of IRC).

Table 5.1 - Number and Percentages of Coded Lines for Email and IRC

High Performing Teams					
Team No.	Email	IRC	Total	Email %	IRC %
H1	351	2525	2876	12%	88%
H2	348	2503	2851	12%	88%
H3	1061	1664	2725	39%	61%
H4	705	4255	4960	14%	86%
Low Performing Teams					
Team No.	Email	IRC	Total	Email %	IRC %
L1	570	1029	1599	36%	64%
L2	844	7675	8519	10%	90%
L3	710	2305	3015	24%	76%
L4	1090	3436	4526	24%	76%

Although a difference in the use of Email and IRC was evident, the differences were not wide. A Significance Test was carried out to check for statistical significance.

5.3. Significance Tests in This Research

A **Significance Test** was performed in order to make a decision about whether or not the differences found in the Email and IRC communication should be seen as showing an actual effect or dismissed as likely to represent just chance fluctuation. A **null hypothesis**[1] **(Ho)** was declared for this analysis as:

> **Ho: there was no difference in the use of Email vs. IRC between the high and low performing teams.**

[1] **Null Hypothesis (Ho)** is defined as a statement of prediction that there are no differences to support the conjecture under investigation (Coolican, 1999).

The significance test in this study hopes to reject this null hypothesis (*Ho*) and prove that there was a significant difference in the use of Email vs. IRC between the high and low performing teams.

The differences compared in the following analyses will be accepted as **significant** and the null hypothesis rejected if the **significance level**[2] is $p < 0.05$ *(5%)* (where p = probability). Differences will be accepted as **highly significant** when the significance level is $p < 0.01$ *(1%)*. Anything above the 5% ($p > 0.05$) significance level is seen as **not significant** and the null hypothesis (*Ho*) will be retained. As per Coolican's (1999) suggestion, the significance tests in the following sections will only use the **two-tailed**[3] tests of significance.

5.3.1. The Chi-Square (X^2) Test

There are several different types of significance tests. Their suitability depends on the type of data and the way it is set up. After careful study of the raw data (Table 5.1) and the tests available, the appropriate test for the task was identified as the **Chi-Square Test (χ^2)**. The Chi-Square Test (χ^2) was used when looking for differences; it required the level of data to be in **nominal form**[4] and the data to be in the form of frequencies. All these conditions specified by the test were evident in the data for this study and therefore the Chi-Square Test (χ^2) was deemed as the correct significance test to use.

The Chi-Square Test (χ^2) requires the data to be set up in a contingency table, which presents the **observed frequencies** (original data) in the form of rows and columns. Table 5.2 below shows the **observed frequencies** for this study.

---

[2] A **significance level** is the level of probability at which it is agreed that the null hypothesis will be rejected (Coolican, 1999).

[3] A **two-tailed** test has a non-directional hypothesis, which makes a prediction of a difference but does not state the direction. A **one-tailed** test has a directional hypothesis, which makes a prediction of the direction of the results.

Table 5.2 - Observed Frequencies

Team No.	Email	IRC	Total
H1	351	2525	2876
H2	348	2503	2851
H3	1061	1664	2725
H4	705	4255	4960
L1	570	1029	1599
L2	844	7675	8519
L3	710	2305	3015
L4	1090	3436	4526
Total	5679	25392	31071

Column 1 in Table 5.2 identifies the team number and its placement in performance as high (H) or low (L).

Columns 2 and 3 show the frequencies of the coded lines for Email or IRC for each team.

Column 4 adds the frequencies of both Email and IRC for each team.

The next step in the Chi-Square Test (χ^2) was to find the **expected frequency**[5]. The formula for calculating the **expected frequency (E)** is:

E = RC/T
Where:
R = total of row cells
C = total of column cells
T = total of all cells
(Coolican, 1999; Sirkin, 1995; Rowntree, 1991)

An **expected frequency** was calculated using the formula above for each cell of the **observed frequency** in the table. This then gave an extra column(s) in Table 5.2for the corresponding **expected frequencies**.

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[4] **Nominal form** - level at which numbers are mere labels on a scale identifying discrete categories.

[5] **Expected frequencies** are frequencies hypothetical expected if no relationship exists between the variables. In other words, if the null hypothesis (*H0*) was to be retained.

The Chi-Square Test (χ^2) formula is:

$\chi^2 = \Sigma (O-E)^2/E$
Where
O = Observed frequency
E = Expected frequency
(Coolican, 1999; Sirkin, 1995; Rowntree, 1991).

In order to find the level of significance for the obtained χ^2 value, it was necessary to first work out the **degrees of freedom (df)**[6]. The formula for calculating the **degrees of freedom (df)** is:

df = (R-1)(C-1)
Where
R = the number of Rows
C = the number of Columns
(Coolican, 1999; Sirkin, 1995; Rowntree, 1991)

Once the values for the Chi-Square Test (χ^2) and the degrees of freedom were obtained, a level of probability was found using the significance table of the critical values of χ^2. A copy of the table can be seen in Appendix 5.1. A decision was then made as to whether or not the Chi-Square Test (χ^2) result was significant or not and if the null hypothesis (*Ho*) would be rejected or retained.

5.4. Significance Tests On Email and IRC

There were four issues within the team communication that were tested for significance. These issues were:

The distribution of total communication for each team.

The distribution of totals within the overall high and low performance.

A comparison of Email vs. IRC for individual teams.

---

[6] The **degrees of freedom (df)** is explained as the number of cells in a frequency table which are free to vary if row and column totals are known (Coolican, 1999).

A Comparison of Email vs. IRC for overall high and low performance.

The following sections show the significance tests for each of these issues and the results obtained from the tests.

5.4.1. Distribution Of Total Communication

Examination of the distribution of total communication suggested that the 8 teams used in this study were very different in their total number of communications. The null hypothesis (*Ho*) for this test is:

Null Hypothesis

Ho: there were no significant differences in the total number of communication within the 8 teams.

As this test looked at only one variable, the total communication, the Chi-Square Test (χ^2) used here was the **Goodness of Fit** test. The formulas stated above for the Chi-Square Test (χ^2) will be the same, however, the calculations for the **expected frequencies** and the **degrees of freedom** will be calculated differently.

The **expected frequencies** were calculated based on the null hypothesis that all cells should be equal. The **degrees of freedom** was calculated as *k-1* where *k* = the number of rows.

For this test, the *expected frequencies* (E) were calculated by dividing the total of the observed frequencies by the number of rows (31071/8 = 3884). The *degrees of freedom* was calculated using the formula *(k-1, where k=8)*, therefore 8-1 = 7. Table 5.3 below shows the test results.

Column 1 contains the team identification numbers.

Column 2 has the observed frequencies (O).

Column 3 represents the calculated expected frequencies.

Column 4 has the results of the Chi-Square Test (χ^2) as explained in section 5.3.1.

Table 5.3 - Distribution of Totals within Individual Teams

Team No.	**Total (O)**	**Total (E)**	**Chi-SQ Test (χ^2)**
H1	2876	3884	262
L1	1599	3884	1344
H2	2851	3884	275
L2	8519	3884	5532
H3	2725	3884	346
L3	3015	3884	194
H4	4960	3884	298
L4	4526	3884	106
Total (O)	31071		
Chi-Square Total			8357

The Chi-Square Test (χ^2) result was 8357 with 7 *degrees of freedom* (as previously calculated).

Result

The result was **highly significant** with $p<0.001$. The null hypothesis (*Ho*) in this test was not supported. The eight teams studied were very different in their total number of communications.

5.4.2. Distribution Of High And Low Totals

Examination of the distribution of totals within the high and low performing groups suggested that one reason for the difference among the eight teams is that the high performance teams tended to make fewer communications than the low performing teams.

The null hypothesis (*Ho*) for this test is:

Null Hypothesis

Ho: there was no significant difference between the overall communications of the high and low performing teams.

This test, just as the previous test, looks at only one variable, the total communication. As per the previous test the *Goodness of Fit* test was used. The formulas and calculations for the *expected frequencies* (31071/2 = 15535.5) and the *degrees of freedom (k-1 where k=2* therefore 2-1 = 1) was calculated as stated in section 5.4.1.

Table 5.4 below shows the test results.

Column 1 identifies the overall performance as high or low.

Column 2 has the observed frequencies (O).

Column 3 shows the calculated expected frequencies.

Column 4 has the results of the Chi-Square Test (χ^2).

Table 5.4 - Distribution of Totals for High and Low Performing Groups

Team Performance	Total Observed	Total Expected	Chi-SQ Test (χ^2)
High Total	13412	15535.5	290
Low Total	17659	15535.5	290
			Chi-Square Total
Total	**31071**		**581**

The Chi-Square Test (χ^2) result was 581 with 1 *degrees of freedom* (as previously calculated).

Result

The result was **highly significant** with $p<0.001$. The null hypothesis (*Ho*) in this test was not supported. The results show that one possible reason for the difference among the eight teams was that the high performance teams tend to make fewer communications than the low performance teams.

5.4.3. Comparison Of Email Vs IRC For All Teams

The comparison of Email vs. IRC for all 8 teams suggested that the 8 teams were also very different in their use of Email as opposed to IRC. The null hypothesis (*Ho*) for this test is:

Null Hypothesis

Ho: there was no significant difference between the Email and IRC usage between the 8 individual teams.

This test, unlike the previous two tests, looked at more than one variable, the Email communication and the IRC communication. The Chi-Square Test (χ^2) used here was the standard test and used the formulas for the Chi-Square Test (χ^2) explained in section 5.4.

For this test, the *expected frequencies* (E) were calculated by using the E = RC/T formula. The values therefore differed for each cell. The *degrees of freedom* was calculated using the formula df = (R-1)(C-1). For this test, the *degrees of freedom (df)* was calculated as *df*= (8-1)(2-1) = 7 * 1 = 7.

Table 5.5 below illustrates the test results.

Column 1 contains the team identification numbers.

Column 2 has the observed frequencies (O) for Email.

Column 3 has the observed frequencies (O) for IRC.

Column 4 has the observed frequencies (O) for the total communication (Email and IRC).

Column 5 shows the calculated expected frequencies (E) for Email.

Column 6 shows the calculated expected frequencies (E) for IRC.

Columns 7, 8 and 9 have the results of the Chi-Square Test (χ^2) as explained earlier in this chapter.

Table 5.5 - Comparison of Email vs. IRC for all 8 Teams

Comparison of Email vs IRC for all 8 Teams						**Chi-SQ Test (χ^2)**		
Team No.	**Email (O)**	**IRC (O)**	**Total (O)**	**Email (E)**	**IRC (E)**	**Chi-Email**	**Chi-IRC**	
H1	351	2525	2876	525.7	2350.3	58.0	13.0	
L1	570	1029	1599	292.3	1306.7	263.9	59.0	
H2	348	2503	2851	521.1	2329.9	57.5	12.9	
L2	844	7675	8519	1557.1	6961.9	326.5	73.0	
H3	1061	1664	2725	498.1	2226.9	636.3	142.3	
L3	710	2305	3015	551.1	2463.9	45.8	10.3	
H4	705	4255	4960	906.6	4053.4	44.8	10.0	
L4	1090	3436	4526	827.2	3698.8	83.5	18.7	
Total	5679	25392	31071	5679.0	25392.0	1516.4	339.1	
							Chi-SQ Total	1855.6

The Chi-Square Test (χ^2) result was 1855.6 with 7 *degrees of freedom.*

Result

The result was **highly significant** with $p<0.001$. The null hypothesis (*Ho*) in this test was not supported. The results show that the 8 teams were also very different in their use of email as opposed to IRC.

5.4.4. Comparison Of Email Vs. IRC For High And Low Totals

The comparison of Email vs. IRC for the total high and low performance surmised that there was a difference between the use of the two types of communication between the high and low performance teams. The null hypothesis (*Ho*) for this test is:

Null Hypothesis

Ho: there were no significant differences between the use of Email and IRC between the total high performing teams and low performing teams.

This test, like the previous test, looked at more than one variable, the Email communication and the IRC communication. The Chi-Square Test (χ^2) used here was the standard test.

For this test, the *expected frequencies* (E) were calculated by using the E = RC/T formula so the values differed for each cell. The *degrees of freedom* was calculated using the formula df = (R-1)(C-1). For this test, the *degrees of freedom (df)* was calculated as *df* = (2-1)(2-1) = 1 * 1 = 1.

Table 5.6 below illustrates the test results.

Column 1 identifies the overall performance as high or low.

Column 2 has the observed frequencies (O) for Email.

Column 3 has the observed frequencies (O) for IRC.

Column 4 has the observed frequencies (O) for the total communication (Email and IRC).

Column 5 shows the calculated expected frequencies (E) for Email.

Column 6 shows the calculated expected frequencies (E) for IRC.

Columns 7, 8 and 9 have the results of the Chi-Square Test (χ^2) as explained earlier in this chapter.

Table 5.6 - Comparison of Email vs. IRC for High and Low Performing Groups

Compare Email Vs IRC For High/Low Performing Groups						Chi-SQ Test (χ^2)	
Team Performance	Email (O)	IRC (O)	Total (O)	Email (E)	IRC (E)	Chi-Email	Chi-IRC
High Total	2465	10947	13412	2451.4	10960.6	0.08	0.02
Low Total	3214	14445	17659	3227.6	14431.4	0.06	0.01
Total	5679	25392	31071	5679.0	25392.0	0.13	0.03
						Chi-SQ Total	0.16

The Chi-Square Test (χ^2) result was 0.16 with 1 *degrees of freedom.*

Result

The result was **not significant** with p>0.05. The null hypothesis (*Ho*) in this test was supported. The results show that there was NOT a significant difference between the use of the two types of communication between the high performing groups and low performing groups.

5.5. Correlation Tests

As part of the search for high and low performing teams, the Team Average Mark (TAM) was ranked from highest mark to lowest mark (explained in Chapter 4). It was recognised that the teams' total communication could also be ranked from highest total communication to lowest total communication. A comparison of ranking was undertaken using Spearman's rank **correlation**[7].

Spearman's rank correlation test uses a 'special case formula', which in turn uses the differences between ranked pairs of values taken from each variable. In the case of this analysis, the variables ranked for the test were the team average mark (TAM) and the total communication.

[7] A **correlation test** measures the extent to which pairs of related values on two variables tend to change together (Coolican, 1999).

A correlation can be said to be either **positive** or **negative**.

A **positive correlation** states that as one variable increases, the other variable also increases. In the case of this study, a positive correlation would be that *the more a team communicates the higher the team average mark.*

A **negative correlation** is considered when one variable increases as the other decreases. A negative correlation for this study would be *the more a team communicates the lower the team average mark.*

This test did not make a prediction for either a positive or negative correlation. Instead, the hypothesis predicts a relationship between the team average mark (TAM) ranking and the total communication ranking without stating the direction as either positive or negative. This therefore used a two-tailed test (non-directional hypothesis). The null hypothesis (*Ho*) for this test is:

Null Hypothesis

Ho: there was no relationship between the team average mark (TAM) ranking and the total communication ranking.

The correlation was measured by the strength of relationship between the two variables. This strength looks at the degree to which one variable increases as the other either increases (positive) or decreases (negative). This relationship is expressed via a scale that ranges from –1 (perfect negative) to zero (no relationship) to +1 (perfect positive). The number used to express the relationship is called the **correlation coefficient** (Coolican, 1999). The correlation coefficient is considered the **critical value**[8] and was subjected to the scrutiny of the probability levels previously explained in section 5.3.

5.5.1. Spearman's Rho

As with significance tests, there is more than one correlation test. Their suitability is dependent on the type of data available. Spearman's correlation test, more commonly known as Spearman's ρ (usually written as rho and pronounced ro) looks at the degree of correlation between two sets of paired ranks and requires data to be in the form of related pairs of values. The conditions required by this study consider the Spearman's Rho test the correct correlation test to use. Table 5.1 below illustrates the data as required by Spearman's Rho test.

Table 5.7 - TAM Ranking Compared with Total Communication

Team No.	Tot Comm	TAM	Tot Com Rank	TAM Rank	Difference between ranks (d)	Diff-Squared (d^2)
H1	2876	4.83	5	4	1	1
L1	1599	3.06	8	8	0	0
H2	2851	4.86	6	3	3	9
L2	8519	3.56	1	7	-6	36
H3	2725	4.97	7	1	6	36
L3	3015	3.67	4	6	-2	4
H4	4960	4.89	2	2	0	0
L4	4526	3.8	3	5	-2	4
					Total (Σd^2) =90	

[8] **Critical value** is a value with which a statistic, calculated from sample data, can be compared in order to decide whether a null hypothesis should be rejected; the value is related to the particular level of probability chosen (Coolican, 1999).

The formula used in **Spearman's Rho** test is:

$r_S = 1 - 6\Sigma d^2/N(N^2 - 1)$
Where
D = difference between ranks
D^2 – difference between ranks (d) squared
N = the number of pairs

Having calculated and replaced all the values required for the formula, the correlation coefficient (r_S) was 0.071. The obtained value (correlation coefficient) was looked up in the **significance table** of the critical values of Spearman's ρ. A copy of the table can be seen in Appendix 5.2.

Result

The result was **not significant** with $p>0.05$. The null hypothesis was supported as the results show that there was NO relationship between the team average mark (TAM) ranking and the total communication ranking.

5.6. Communication Types

The text-based communication for the 8 teams identified (Chapter 4) as high performing and low performing was categorised using the categories developed for this research (Chapter 4). Analysis investigated the percentage use (sections 5.6.1 and 5.6.3) and the use during a three time period –explained below (sections 5.6.2 and 5.6.4) for the top-level and sub-level categories for all teams. Because there was such diversity in the quantities of frequencies between all teams, a percentage was used for a fair comparison.

The three periods used in this research reflect the software development lifecycle within the course structure. The software development for each team is discussed in further detail in Chapter 7.

Period 1 (P1) - encompassed the first three weeks, which had as deliverables: the project introduction (week 1), team building (week 2) and the design documentation (week 3).

Period 2 (P2) - took into account weeks 4, 5 and 6. The deliverables for these weeks were motor controller (week 4), video processor (week 5) and server/project progress (week 6).

Period 3 (P3) - accounted for the last three weeks, which had as deliverables the client communication/client server (week 7), and the final presentation (weeks 8 and 9).

5.6.1. Top-Level Category Frequency

Analysis in section 5.4.1 found that all teams were different in total amount of communication. Categorisation looks at the type of communication for each team. Since there was a difference in the total amount of communication for all teams the question in this observation is

Question

Q-were the teams different in their percentage use of top-level communication type?

Figure 5.1 below shows a similar pattern of the percentage usage of top-level categories across all teams.

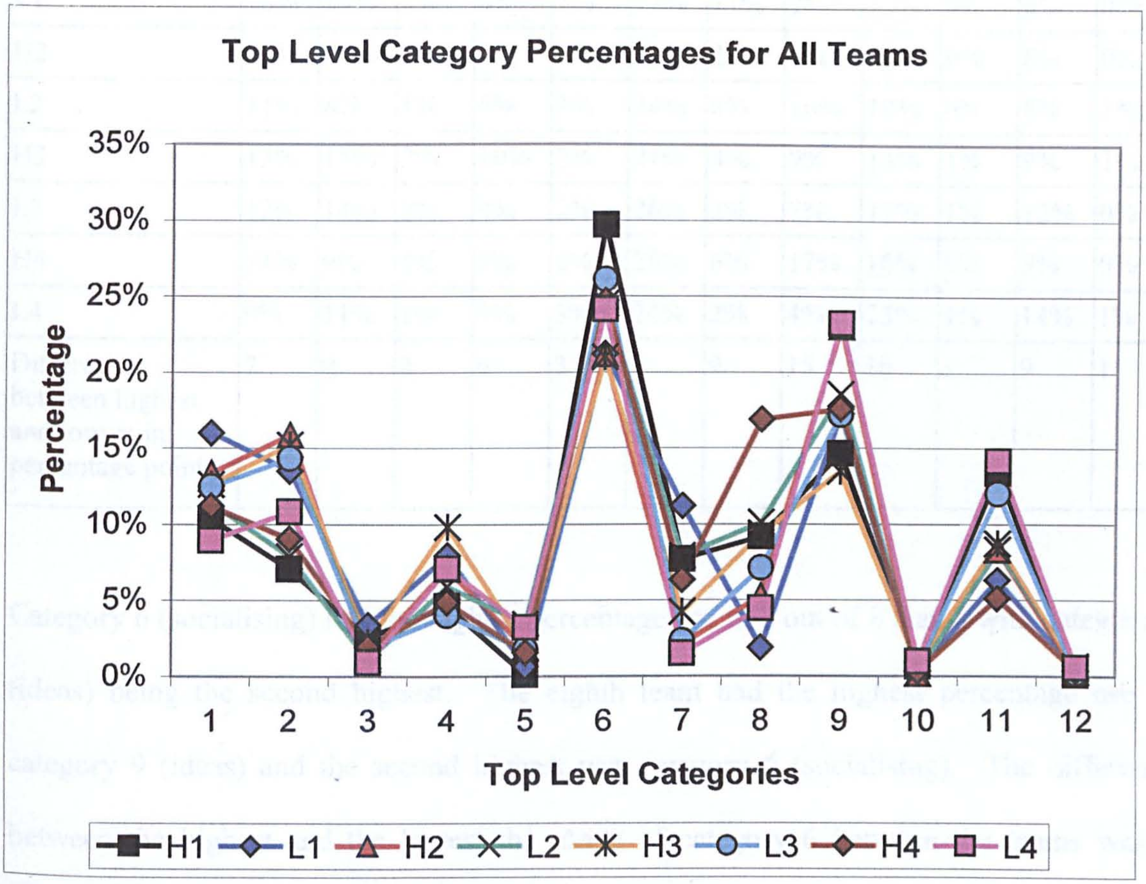


Figure 5.1 - Percentage of Category Usage for All Teams

Table 5.8 below shows the numerical percentages for each team against each category used to create Figure 5.1. The last row shows the difference between the highest percentage and the lowest percentage in percentage points.

Table 5.8 - Top Level Category Percentages for All Teams

Team No.	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
H1	10%	7%	3%	5%	0%	30%	8%	9%	15%	1%	13%	0%
L1	16%	14%	3%	8%	1%	21%	11%	2%	17%	0%	6%	0%
H2	13%	16%	1%	7%	2%	21%	2%	5%	23%	0%	8%	0%
L2	11%	8%	1%	6%	3%	24%	8%	10%	19%	0%	8%	1%
H3	13%	15%	2%	10%	2%	21%	4%	9%	13%	1%	9%	1%
L3	12%	14%	2%	4%	2%	26%	2%	7%	17%	1%	12%	0%
H4	11%	9%	2%	5%	2%	25%	6%	17%	18%	0%	5%	0%
L4	9%	11%	1%	7%	3%	24%	2%	4%	23%	1%	14%	1%
Difference between highest and lowest in percentage points	7	9	2	6	3	9	9	15	10	1	9	1

Category 6 (socialising) had the highest percentage use in 7 out of 8 teams with category 9 (ideas) being the second highest. The eighth team had the highest percentage use of category 9 (ideas) and the second highest was category 6 (socialising). The difference between the highest and the lowest the usage of category 6 between the teams was 9 percentage points. Other categories such as C2 (Planning Admin), C7 (Humour) and C11 (Task/Work Specific) had the same differences in percentage points. The only category that had more than the 10 percentage points difference was C8 (Graphical Expressions), which had a difference of 15 percentage points.

Table 5.9 below shows the highest and lowest of top-level categories for all the teams.

Column 1 shows the top-level category reference and name. The set of top-level and sub-level categories can be found in Chapter 4. Their explanation and an example can be found in Appendix 4.5.

Column 2 shows the team(s) that had the highest percentage use and their performance position, i.e. low or high.

Column 3 shows the team(s) that had the lowest percentage use and their performance position, i.e. low or high.

Table 5.9 - Highest and Lowest Occurrence of Top-Level Categories in Teams

Category	Team with highest percentage use	Team with lowest percentage use
C1 Planning Work	L1	L4
C2 Planning Admin	H2	H1
C3 Decisions	H1 and L1	H2 L2 L4
C4 Roles	H3	L3
C5 Conflict	L2 and L4	H1
C6 Social/Get to know	H1	L2 H2 H3
C7 Humour	L2	H2 L3 L4
C8 Graphical Expression	H4	L1
C9 Ideas	H2 and L4	H3
C10 Identification	H1 H3 L3 L4	L1 H2 L2 H4
C11 Task/Work Specific	L4	H4
C12 Goals	L2 H3 L4	H1 L2 H2 L3 H4

Nine out of 12 of the top-level categories showed differences in the percentage use between the high performing teams and the low performing teams. A high performing team had the highest percentage use of category 4 (Roles) and category 8 (Graphical Expressions) where a low performing team had the lowest amount. In category 11 (Task/Work Specific), one low performing team had the highest percentage use while one high performing team had the lowest percentage use. Two low performing teams had the highest percentage use of category 5 (Conflict) and one high performing team had the lowest percentage use. This is consistent with the group development findings (Chapter 8) that showed low performing teams had more conflict than the high performing teams.

Result

The range of use between teams in each category was minimal as stated above. The pattern of use was similar for all teams. Differences in the percentage use of each communication type between were as high as 15 percentage points.

5.6.2. Top-Level Category over Time

As there were similar patterns in the top-level category use between the teams, it was decided to look at each team's use of categories along the project's timeline. Because of the large quantity of graphs it would take to show each top-level category for each team, it was decided to put this information in a table instead. Table 5.10 below shows the periods (P1, P2, P3) for each team with the highest and lowest occurrences of each top-level category.

Column 1 shows the team number and their performance position, i.e. low or high.

Columns 2-13 show the individual categories 1-12.

Rows 3-10 (highest occurrence) and 14-21 (lowest occurrence) denote the period (P1, P2, P3) for each team where the highest or lowest occurrence of each top-level category occurred.

Rows 11 and 22 give the total amount of occurrences for each period in each category.

Section 5.4.2 found a difference between the high performing teams and the low performing teams in their total communication. This section looks at each team's use of category types along the project's timeline. The question for this observation is

Question

Q - was there a difference between the high performing teams and the low performing teams in their use of top-level categories along the project's timeline?

Table 5.10 - Top-Level Category Highest and Lowest Occurrences along Timeline for all Teams

Highest Occurrence in Period												
Teams	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**
H1	P3	P3	P1	P3	P2	P3	P3	P3	P3	P1	P3	P3
H2	P2	P2	P2	P2	P2	P2	P1	P2	P2	P1	P2	P1
H3	P2	P1	P2	P2	P3	P3	P2	P3	P2	P1	P3	P3
H4	P2	P2	P2	P2	P2	P2	P2	P2	P2	P1	P2	P2
L1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P3	P1
L2	P2	P2	P1	P1	P3	P2	P2	P2	P1	P1	P2	P3
L3	P2	P3	P1	P2	P3	P2and P3	P2and P3	P2	P2	P1	P2and P3	P3
L4	P2	P2	P2	P3	P3	P3	P3	P3	P3	P3	P3	P3
Totals	**P1=1 P2=6 P3=1**	**P1=2 P2=4 P3=2**	**P1=4 P2=4 P3=0**	**P1=2 P2=4 P3=2**	**P1=1 P2=3 P3=4**	**P1=1 P2=4 P3=4**	**P1=2 P2=4 P3=3**	**P1=1 P2=4 P3=3**	**P1=2 P2=4 P3=2**	**P1=7 P2=0 P3=1**	**P1=0 P2=4 P3=5**	**P1=2 P2=1 P3=5**
Lowest Occurrence in Period												
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**
H1	P2	P2	P2	P1	P3	P1	P1	P1	P2	P2	P1	P1and P2
H2	P3	P1	P3	P3	P1	P1	P3	P1	P1	P3	P1	P2
H3	P1	P3	P3	P3	P1	P2	P3	P1	P1	P2	P1	P1
H4	P3	P3	P3	P3	P3	P3	P3	P3	P3	P3	P1	P3
L1	P3	P2and P3	P3	P3	P2	P3	P3	P3	P3	P2	P1	P3
L2	P3	P3	P3	P3	P1	P1	P1	P1	P3	P3	P1	P1
L3	P3	P1	P2	P1	P1	P1	P1	P1	P3	P2and P3	P1	P1
L4	P1	P1	P1	P1	P1	P1	P1	P1	P1	P2	P1	P1
Totals	**P1=2 P2=1 P3=5**	**P1=3 P2=2 P3=4**	**P1=1 P2=2 P3=5**	**P1=3 P2=0 P3=5**	**P1=5 P2=1 P3=2**	**P1=5 P2=1 P3=2**	**P1=4 P2=0 P3=4**	**P1=6 P2=0 P3=2**	**P1=3 P2=1 P3=4**	**P1=0 P2=5 P3=4**	**P1=8 P2=0 P3=0**	**P1=5 P2=2 P3=2**

Table 5.11 below gives a summary of the highest and lowest top-level category occurrences shown in Table 5.10 above.

Column 1 shows the 12 top-level categories.

Columns 2 and 4 show the period with the highest and lowest number of teams. This is taken from rows 11 and 22 of Table 5.10.

Columns 3 and 5 show the breakdown of the teams and their position (high/low) that had the highest or lowest occurrence within the periods specified in columns 2 and 4.

Table 5.11 - Summary of Top-Level Category Highest and Lowest Occurrences along Timeline for all Teams

Categories	Highest Period	Team Breakdown	Lowest Period	Team Breakdown
C1 Planning Work	P2	3 high / 3 low	P3	2 high / 3 low
C2 Planning Admin	P2	2 high / 2 low	P3	2 high / 2 low
C3 Decisions	P1 and P2	P1=1 high / 3 low P2=3 high / 1 low	P3	3 high / 2 low
C4 Roles	P2	3 high / 1 low	P3	3 high / 2 low
C5 Conflict	P3	1 high / 3 low	P1	2 high / 3 low
C6 Social/Get to know	P2 and P3	P2=2 high / 2 low P3 = 2 high / 2 low	P1	2 high / 3 low
C7 Humour	P2	2 high / 2 low	P1 and P3	P1=1 high / 3 low P3=3 high / 1 low
C8 Graphical Expression	P2	2 high / 2 low	P1	3 high / 3 low
C9 Ideas	P2	3 high / 1 low	P3	1 high / 3 low
C10 Identification	P1	4 high / 3 low	P2	2 high / 3 low
C11 Task/Work Specific	P3	2 high / 3 low	P1	4 high / 4 low
C12 Goals	P3	2 high / 3 low	P1	2 high / 3 low

Eight out of 12 of the top-level categories had the highest occurrence during period 2. These also had an even breakdown of distribution between the high and low performing teams. The top-level categories that had the highest occurrence during period 3 were C5 – conflict, C11 – Task/Work Specific and C12 – Goals. Although the distribution of the high performing teams and the low performing teams was not even, the differences were not distinguishable. C6 – social/get to know had an even breakdown between periods 2 and 3. It also had an even breakdown in teams.

The majority of top-level categories had the lowest occurrence during periods 1 and 3. Eleven of these also had an even or indistinguishable distribution between the high performing teams and the low performing teams.

The differences between high performing teams and low performing teams occurred in the highest occurrence of C3 (decisions), C4 (roles), C5 (conflict) and C9 (ideas). Three of the high performing teams made more (C3) decisions during period 2 whereas three of the low performing teams made more decisions during period 1. More analysis on decision-making in teams is outlined in Chapter 6. More of the high performing teams (3 out of 4) had more occurrences of (C4) roles and (C9) ideas than the low performing teams. Identification of roles and ideas will also be considered in the team profile detailed in Chapter 8. More of the low performing teams (3 out of 4) had more occurrences of (C5) conflict than the high performing teams. This is consistent with findings in Chapter 8 where the low performing teams had more conflict than the high performing teams.

Result

There were some differences between the high performing teams and the low performing teams in their use of some top-level categories along the project's timeline. These differences were investigated in further analyses in later chapters.

5.6.3. Sub-Category Frequency

The sub-level categories identify specific actions by each team. Section 5.6.1 investigated the top-level categories for each team and found that the pattern of percentage use was similar among all teams. The question in this observation is

Question

Q-were the teams different in their percentage use of sub-level communication type?

Figure 5.2 (Categories 1-4 sub-levels), Figure 5.3 (Categories 5-8 sub-levels), Figure 5.4 (Categories 9-12 sub-levels) below shows the percentage usage of the sub-level categories across all teams. Because the percentage range varies from category to category, the legend which shows the percentage also varies from graph to graph.

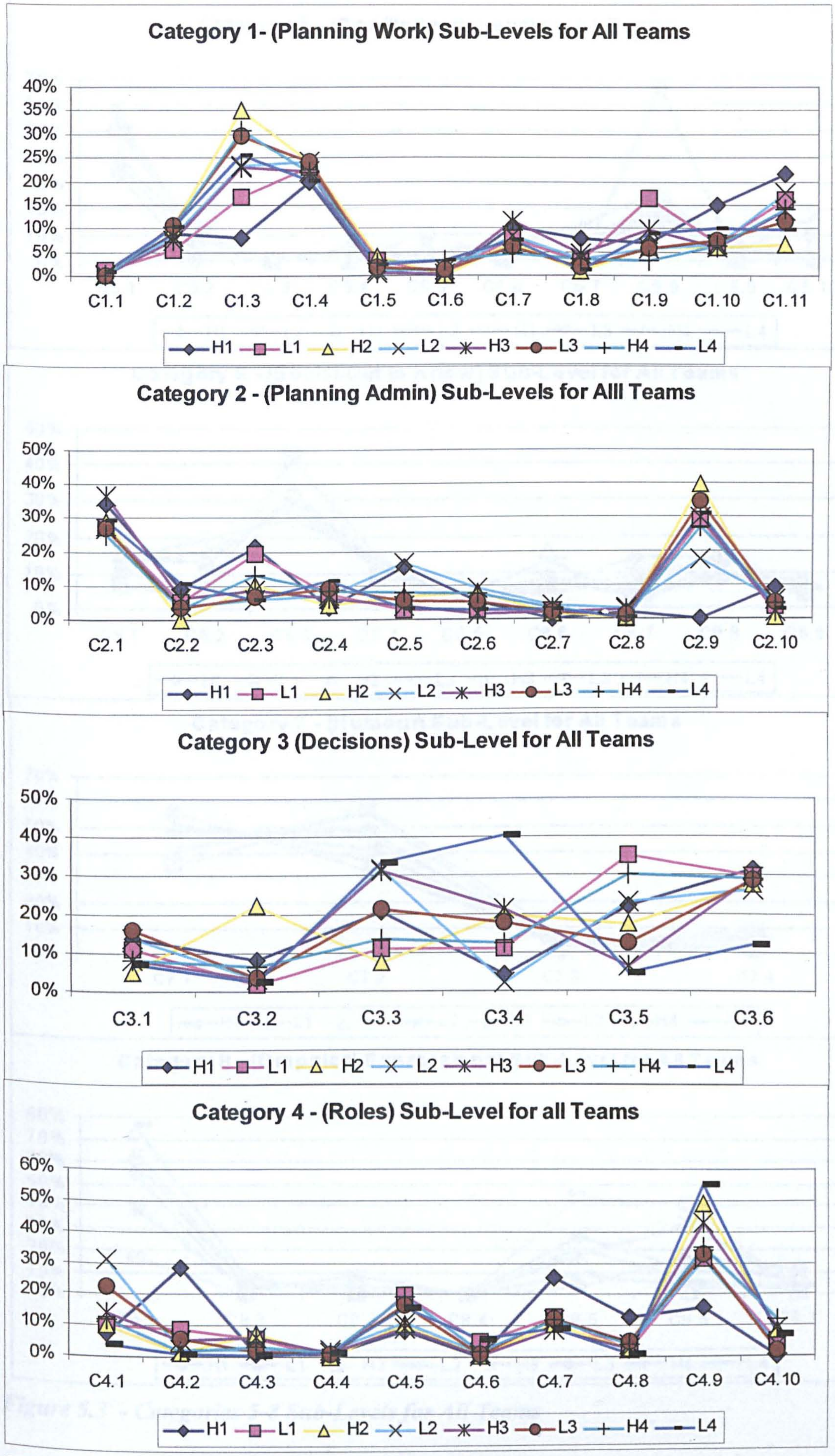


Figure 5.2 - Categories 1-4 Sub-Levels for All Teams

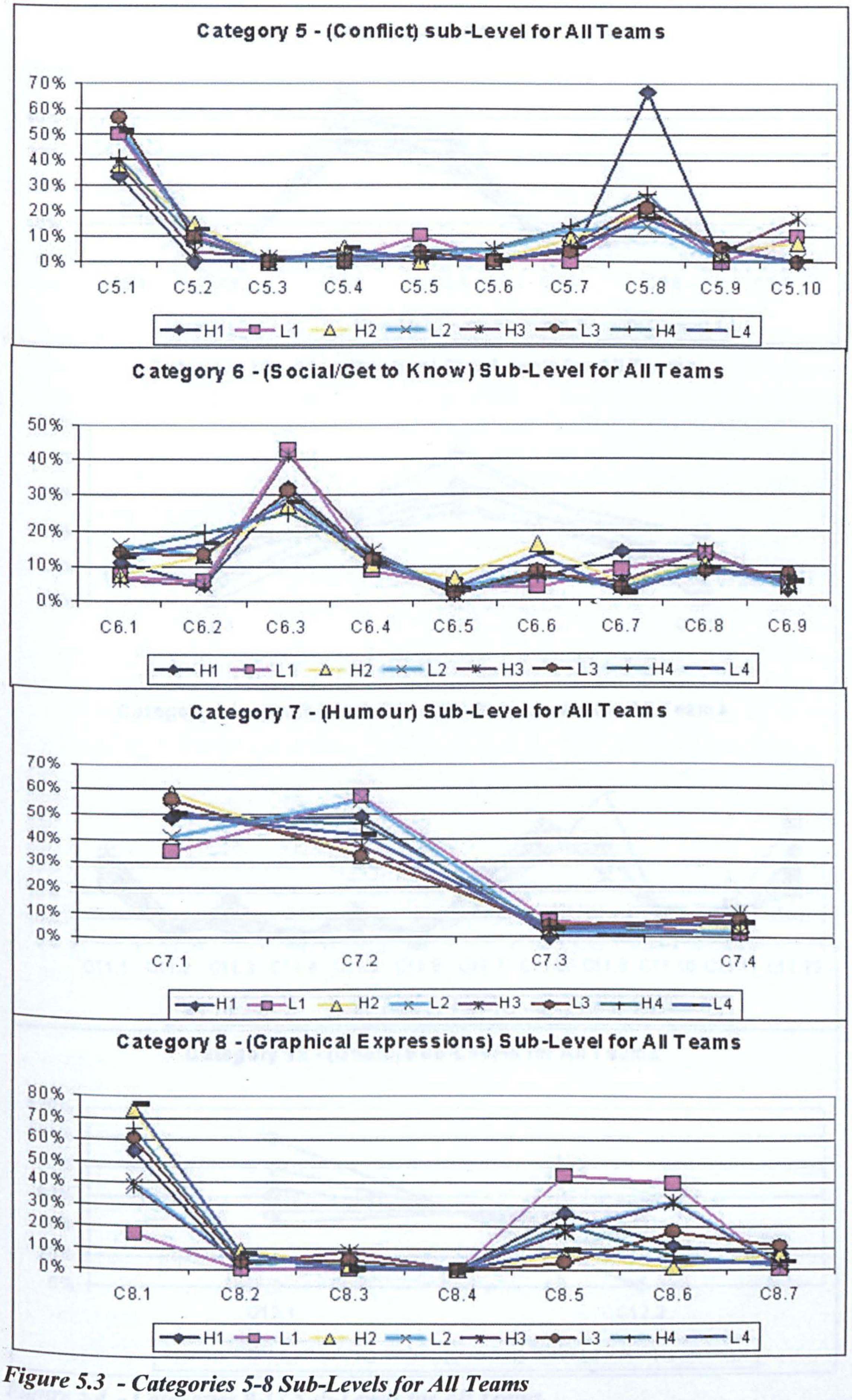


***Figure 5.3** - Categories 5-8 Sub-Levels for All Teams*

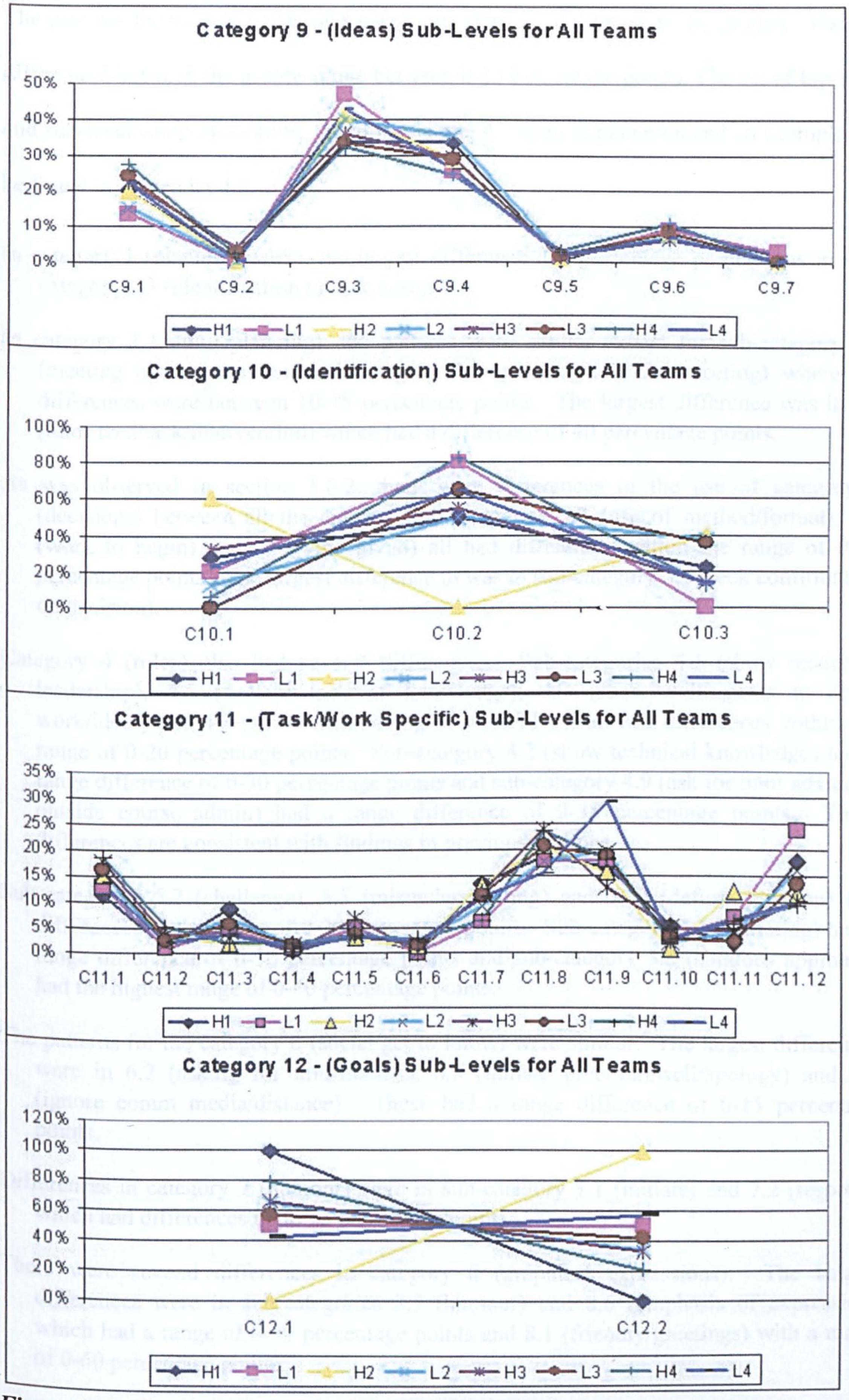


Figure 5.4 - Categories 9-12 Sub-Levels for All Teams

The patterns for the sub-levels of 8 categories were similar between the groups. The differences between the groups range between 0-15 percentage points. The set of top-level and sub-level categories can be found in Chapter 4. Their explanation and an example can be found in Appendix 4.5.

In category 1 (planning work), the largest difference (20 percentage points) was in sub-category 1.3 (identification of task design).

In category 2 (admin planning), the patterns were similar except for sub-category 2.3 (meeting agreements) and sub-category 2.5 (plans/agenda for meeting) where the differences were between 10-15 percentage points. The largest difference was in 2.9 (tutor feedback/intervention) which had a difference of 40 percentage points.

As was observed in section 5.6.2, there were differences in the use of category 3 (decisions) between all the teams. Sub-categories 3.2 (use of method/format), 3.3 (work to begin) and 3.6 (vote given) all had differences within the range of 0-20 percentage points. The largest difference in was in sub-category 3.4 (seek confirmation on decision).

Category 4 (roles) also had several differences. Sub-categories 4.1 (show recognise leadership), 4.5 (declare lack of knowledge), 4.7 (show willingness to share work/ideas) and 4.8 (show withholding of work/ideas) all had differences within the range of 0-20 percentage points. Sub-category 4.2 (show technical knowledge) had a range difference of 0-30 percentage points and sub-category 4.9 (ask for tutor advice or outside course admin) had a range difference of 0-35 percentage points. These differences are consistent with findings in previous sections.

Sub-categories 5.2 (challenge), 5.5 (misunderstanding) and 5.10 (defuse situation) had differences in the range of 0-20 percentage points. Sub-category 5.1 (initiating) had a range difference of 0-30 percentage points and sub-category 5.8 (cautious approach) had the highest range of 0-40 percentage points.

The patterns for the category 6 (social/get to know) were similar. The largest differences were in 6.2 (asking for information), 6.3 (initiate greet/farewell/apology) and 6.7 (ignore comm media/distance). These had a range difference of 0-15 percentage points.

Differences in category 7 (humour) were in sub-category 7.1 (initiate) and 7.2 (respond) which had differences up to 25 percentage points.

There were several differences in category 8 (graphical expressions). The largest differences were in sub-categories 8.5 (humour) and 8.6 (emphasis of expression) which had a range of 0-40 percentage points and 8.1 (friendly/greetings) with a range of 0-60 percentage points.

The patterns in category 9 (ideas) were similar with differences in the range of 0-15 percentage points.

The biggest difference in category 10 (identification) was that team L1 (low performing) had an opposite pattern from the other teams. The largest range difference of 0-80 percentage points was in sub-category 10.2 (identification with sub-group). The range of difference between the teams not including team L1 was within 40 percentage points for all the sub-categories.

The patterns in category 11 (task/work specific) were similar with differences in the range of 0-15 percentage points.

In category 12 (goals), team L1 again showed a different pattern from the other teams. Team H1 also showed a different pattern from the other teams and opposite from team L1's pattern. The other teams had a range difference of 0-40 percentage points in sub-category 12.1 (team goals) and 0-60 percentage points in sub-category 12.2 (personal goals).

Result

Unlike the top-level category frequency in section 5.6.1, there were some differences in the pattern of use between all teams. These differences were investigated in further analyses in later chapters.

5.6.4. Sub-Category over Time

Findings in the sub-category frequency showed some differences in the pattern of use between all the teams. It was decided to look at each team's use of sub-categories along the project's timeline. The number of graphs produced while investigating each team's sub-level categories was 96 (12 categories x 8 teams). The data used to create these graphs can be found in Appendix 5.4. Because of space limitations, the graphs will not be represented here. However, the patterns for each team's sub-categories along the three periods (explained in section 5.6) will be summarised in a series of tables. Each table outlines the sub-levels for each category. The teams were assigned a symbol, which represents the direction each sub-level category had taken from period to period. The symbols and their meanings are outlined in Table 5.12 below.

Table 5.12 - Symbol Chart Representing Direction from Period to Period

Pattern Symbol	Pattern Description
∧	Growth between period 1 to period 2, then a decrease to period 3.
∨	Decrease between period 1 to period 2 then a growth again to period 3.
/	Constant increase between periods 1, 2 and 3.
\	Constant decrease between periods 1, 2 and 3.
¬	Remain constant between periods 1 and 2 but decreases onto period 3.
┘	Remain constant between periods 1and 2 but increases onto period 3.
└	Decrease between periods 1and 2 then remained constant to period 3.
┌	Increase between periods 1and 2 then remained constant to period 3.
—	Steady (no increase or decrease) between periods 1, 2 and 3.

Section 5.6.2 found differences between the high performing teams and the low performing teams in their use of some top-level categories along the project's timeline. This section looks at each team's use of sub-level categories along the project's timeline. The analysis in this section will look for differences and similarities in patterns between all teams. It will also look for patterns that differentiate between the high performing groups and the low performing groups. These patterns are followed by 3 of the high performing groups and by 3 of the low performing groups. The question for this observation is

Question

Q - was there a difference between the high performing teams and the low performing teams in their use of sub-level categories along the project's timeline?

Table 5.13 - Three Period Pattern for Sub-Levels of Category 1 (Planning Work)

Three Period Pattern for Sub-Levels of Category 1 (Planning Work)											
Team	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.10**	**1.11**
H1	∧	\	└	∨	∨	—	/	/	∨	/	/
H2	∧	\	∧	∧	∧	—	∧	∧	∨	∧	∧
H3	┘	∨	∧	∧	¬	┘	┘	∧	∨	/	∧
H4	—	\	∧	∧	\	/	∨	∧	∧	∧	∧
L1	∨	∧	\	\	\	└	∧	/	└	∧	∨
L2	—	\	\	∧	∨	∨	┌	∧	∨	∧	∧
L3	—	\	\	/	∧	∧	∧	\	\	/	∧
L4	/	∧	∧	∧	∧	∧	/	∧	└	/	/

Table 5.13 above details the three period patterns for sub-levels of category 1. The most common pattern for both the high performing groups and low performing groups was ∧ (growth between period 1 to period 2, then a decrease to period 3). This meant that these teams were doing most of the work planning during the second period. Investigation of the sub-categories gives further information on more specific work planning. The high performing teams had 19 occurrences of this pattern and the low performing teams had 17. C1.3 (identification of task design) was the only sub-category where there were patterns differs between the high performing groups and the low performing groups. The other sub-categories had a variety of patterns.

In sub-category 1.3 (identification of task design), ¾ of the high performing teams had a pattern where the highest use was during period 2. Three quarters of the low performing teams had a pattern where the highest use was during period 1 then decrease onto periods 2 and 3.

Table 5.14 - Three Period Pattern for Sub-Levels of Category 2 (Planning Admin)

Three Period Pattern for Sub-Levels of Category 2 (Planning Admin)										
Team	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**2.8**	**2.9**	**2.10**
H1	∨	/	└	∨	/	/	—	∧	—	/
H2	∧	—	∧	∧	∧	∧	∧	┘	/	┘
H3	\	\	\	∨	∨	└	\	\	∧	∧
H4	\	\	\	∧	∧	∧	∧	┌	∧	¬
L1	\	¬	¬	∧	∨	\	∨	—	∨	∨
L2	∧	∨	\	∧	\	∧	\	∧	∧	∧
L3	/	\	∨	┌	∧	∧	∨	∨	∧	/
L4	∧	∨	∧	/	∧	∧	∧	┌	/	∧

Table 5.14 above details the three period patterns for sub-levels of category 2. The most common pattern for the high performing groups and the low performing groups was ∧ (growth between period 1 to period 2, then a decrease to period 3). This meant that these teams were again doing most of the admin planning during the second period. Investigation of the sub-categories gives further information on more specific admin planning. All sub-categories for category 2 showed different patterns for both the high performing groups and the low performing groups. The teams were different in the use of category 2 but there were no patterns that differentiated between the high performing groups and the low performing groups.

Table 5.15 - Three Period Pattern for Sub-Levels of Category 3(Decisions)

Three Period Pattern for Sub-Levels of Category 3 (Decisions)						
Team	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**
H1	\	⌊	∧	∨	∨	∨
H2	∧	∧	∧	∧	¬	⌊
H3	\	∧	∧	∧	∧	∧
H4	∧	¬	∧	∧	\	∧
L1	⌊	∧	⌊	⌊	∧	⌊
L2	\	—	∧	⌊	∨	∨
L3	\	∨	\	⌋	\	∨
L4	∧	⌊	∧	/	⌈	⌈

Table 5.15 above details the three period patterns for sub-levels of category 3. The most common pattern (14 occurrences) for the high performing groups was ∧ (growth between period 1 to period 2, then a decrease to period 3). This meant that these teams were doing most of the decisions-making during the second period. Investigation of the sub-categories gives further information on more specific decision-making.. The most common pattern (6 occurrences) for the low performing teams was ⌊ (decrease between periods 1and 2 then remained constant to period 3). Decision-making for the low performing groups was between periods 1 and 2.

All sub-categories for category 3 showed different patterns for all the teams. Sub-category 3.3 (decision on work to begin) showed the same pattern of ∧ for all the high performing teams and half of the low performing teams. The other two teams had different patterns from each other and from the rest of the teams. Except for this sub-category, the teams were different in their decisions on beginning work (C3.3).

Table 5.16- Three Period Pattern for Sub-Levels of Category 4 (Roles)

Three Period Pattern for Sub-Levels of Category 4 (Roles)										
Team	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.7**	**4.8**	**4.9**	**4.10**
H1	∨	∧	\	/	┌	—	/	∨	∧	—
H2	└	/	┐	—	∨	\	∧	┌	∧	\
H3	∨	/	\	∧	∧	\	∧	┘	∧	\
H4	∧	┌	∨	\	∧	└	\	\	∧	\
L1	\	∨	└	—	\	∨	└	\	\	└
L2	\	∧	∧	—	∧	∧	\	┐	/	\
L3	/	∧	└	∧	∧	┘	/	∨	∧	∧
L4	/	┘	∧	∧	/	/	∧	∨	/	∨

Table 5.16 above details the three period patterns for sub-levels of category 4. The most common pattern for the high performing groups and the low performing groups was ∧ (growth between period 1 to period 2, then a decrease to period 3). This meant that the teams were identifying their roles more during the second period. Investigation of the sub-categories gives further information on more specific role identification. All sub-categories showed different patterns for all the teams. Sub-category 4.9 (ask for tutor advice or outside sources) showed the same pattern of ∧ for all the high performing teams and one of the low performing teams. All the teams were different in their recognition of roles (C4).

Table 5.17- Three Period Pattern for Sub-Levels of Category 5 (Conflict)

Three Period Pattern for Sub-Levels of Category 5 (Conflict)										
Team	**5.1**	**5.2**	**5.3**	**5.4**	**5.5**	**5.6**	**5.7**	**5.8**	**5.9**	**5.10**
H1	∧	—	—	—	—	—	—	┐	—	—
H2	/	∧	—	∧	—	—	∧	┌	∧	∧
H3	/	┘	└	∧	∧	—	∧	/	┐	/
H4	∧	∧	—	—	∧	┐	∧	∧	—	—
L1	∨	\	—	—	\	—	—	∨	—	\
L2	/	∨	—	∧	∧	┘	∧	∧	\	└
L3	/	┘	—	—	┘	—	∧	┘	∧	—
L4	/	/	∧	┘	┌	—	/	/	∨	┘

Table 5.17 above details the three period patterns for sub-levels of category 5. The most common pattern for the high performing groups and the low performing groups was — (steady [no increase or decrease] between periods 1, 2 and 3). This pattern means there was no change between periods 1-3 and the teams' conflict (or lack of conflict) was consistent throughout. This pattern could also be assigned when there was no occurrence in any of the three periods. Further investigation on conflict is detailed in Chapter 8.

There were several similarities between the high performing groups and the low performing groups but no differentiating patterns. The teams were similar in their use of sub-categories 5.3 (resolution of [conflict]), 5.4 (reasoning), 5.6 (avoid) and 5.7 (suggest compromise).

Table 5.18- Three Period Pattern for Sub-Levels of Category 6 (Social/Get to know)

Three Period Pattern for Sub-Levels of Category 6 (Social/Get to know)									
Team	**6.1**	**6.2**	**6.3**	**6.4**	**6.5**	**6.6**	**6.7**	**6.8**	**6.9**
H1	∨	∨	/	/	∨	/	/	/	/
H2	∧	∧	∧	∧	/	∧	∧	∧	∨
H3	\	\	/	\	∨	\	∨	┘	∨
H4	\	¬	∧	\	/	\	∧	∧	∧
L1	∨	\	\	\	∨	∨	∨	\	∨
L2	∧	/	∧	/	┌	\	∧	∧	∧
L3	∧	∨	/	\	/	∧	∧	∧	/
L4	/	/	/	/	/	/	/	/	/

Table 5.18 above details the three period patterns for sub-levels of category 6. The most common pattern (14 occurrences) for the low performing teams was / (constant increase between periods 1, 2 and 3). This meant that the low performing teams increased their socialising from period 1 to period 3.. The most common pattern (11 occurrences) for the high performing teams was ∧ (growth between period 1 to period 2, then a decrease to period 3). The high performing teams did most of their socialising during the second

period. Investigation of the sub-categories gives further information on more specific socialising. All sub-categories for category 6 showed different patterns for both the high performing groups and the low performing groups. The teams were different in the use of category 6.

Table 5.19- Three Period Pattern for Sub-Levels of Category 7 (Humour)

Three Period Pattern for Sub-Levels of Category 7 (Humour)				
Team	**7.1**	**7.2**	**7.3**	**7.4**
H1	/	/	—	┘
H2	\	\	∧	∧
H3	∧	∧	\	∧
H4	∧	∧	∧	∧
L1	\	\	└	└
L2	∧	∧	∧	∨
L3	∧	∨	∧	∧
L4	/	/	┌	┘

Table 5.19 above details the three period patterns for sub-levels of category 7. The most common pattern for the high performing groups and the low performing groups was ∧ (growth between period 1 to period 2, then a decrease to period 3). This meant that the teams were using humour mostly during the second period. This is consistent with the most common pattern of socialising (C6) for the high performing groups.. Sub-categories 7.1 (initiate [humour]) and 7.2 (respond [to humour] were similar in both the high performing groups and the low performing groups. All the teams were different in the use of sub-categories 7.3 (to diffuse a situation), 7.4 (local to country or area).

Table 5.20- Three Period Pattern for Sub-Levels of Category 8 (Graphical Expressions)

Three Period Pattern for Sub-Levels of Category 8 (Graphical Expressions)							
Team	**8.1**	**8.2**	**8.3**	**8.4**	**8.5**	**8.6**	**8.7**
H1	/	—	/	—	/	∨	/
H2	∧	∧	\	—	∧	∧	/
H3	/	┘	/	—	∧	∧	┘
H4	∧	∧	∧	—	∧	∧	∧
L1	\	—	—	—	\	└	—
L2	∧	/	∧	—	∧	∧	∧
L3	∧	∧	∧	—	∧	∨	/
L4	/	/	—	—	/	/	┘

Table 5.20 above details the three period patterns for sub-levels of category 8. The most common pattern for the high performing groups and the low performing groups was ∧ (growth between period 1 to period 2, then a decrease to period 3). This meant that the teams were using graphical expressions mostly during the second period. Sub-category 8.4 (surprise) was identical for all teams. All other sub-categories were different but there were no patterns that differentiate between the high performing groups and low performing groups.

Table 5.21- Three Period Pattern for Sub-Levels of Category 9 (Ideas)

Three Period Pattern for Sub-Levels of Category 9 (Ideas)							
Team	**9.1**	**9.2**	**9.3**	**9.4**	**9.5**	**9.6**	**9.7**
H1	∨	└	/	/	┘	∨	∨
H2	∧	—	∧	∧	∧	∧	—
H3	∧	∧	∧	∧	∧	∧	└
H4	∧	∧	∧	∧	∧	∧	—
L1	\	—	\	\	∨	\	∨
L2	\	∧	∧	\	\	\	└
L3	\	\	∧	∨	∧	∧	∧
L4	/	∨	/	/	∧	∧	\

Table 5.21 above details the three period patterns for sub-levels of category 9. The most common pattern (17 occurrences) for high performing teams was ∧ (growth between period 1 to period 2, then a decrease to period 3). This meant that the high performing teams had most of their ideas during the second period. The most common pattern (11 occurrences) for the low performing teams was \ (constant decrease between periods 1, 2 and 3). The low performing teams had most of their ideas during the first period then had less in period 2 and less in period 3. Investigation of the sub-categories gives further information on more specific ideas.

Three-quarters of the high performing groups had the same pattern while ¾ of the low performing groups had a different pattern in sub-category 9.1 (initiate [ideas]). All the teams were different in their use of category 9.

Table 5.22 - Three Period Pattern for Sub-Levels of Category 10 (Identification)

Three Period Pattern for Sub-Levels of Category 10 (Identification)			
Team	**10.1**	**10.2**	**10.3**
H1	∨	└	∨
H2	∧	—	└
H3	∨	∨	\
H4	└	∧	└
L1	└	\	—
L2	∧	\	∧
L3	—	\	∨
L4	/	∨	—

Table 5.22 above details the three period patterns for sub-levels of category 10. The high performing teams had 2 most common patterns with equal occurrences. These were └ (decrease between periods 1and 2 then remained constant to period 3) and ∨ (decrease between period 1 to period 2 then a growth again to period 3). In both these patterns,

period 1 had more occurrences than period 2. This meant that the high performing teams had most of their identification during the first period.

The low performing teams also had 2 most common patterns with equal occurrences. These were \ (constant decrease between periods 1, 2 and 3) and — (steady [no increase or decrease] between periods 1, 2 and 3). This meant that some of the low performing teams had most of their identification during the first period and others were constant in their identification throughout the project.

The teams were different in their use of all three sub-categories of category 10. There were no patterns that differentiated between the high performing teams and the low performing teams.

Table 5.23- Three Period Pattern for Sub-Levels of Category 11 (Task/Work Specific)

Three Period Pattern for Sub-Levels of Category 11 (Task/Work Specific)												
Team	**11.1**	**11.2**	**11.3**	**11.4**	**11.5**	**11.6**	**11.7**	**11.8**	**11.9**	**11.10**	**11.11**	**11.12**
H1	/	/	^	┘	/	^	^	^	^	^	┘	/
H2	/	/	/	/	/	┘	/	/	/	┌	^	/
H3	/	/	/	^	/	—	/	/	/	/	v	/
H4	^	┌	/	^	^	^	^	^	/	/	^	^
L1	/	^	/	└	¬	—	—	v	/	┘	/	^
L2	^	^	/	^	^	^	/	^	^	^	^	^
L3	/	┌	/	^	/	/	┌	^	/	^	^	^
L4	/	/	/	/	/	^	/	/	/	/	/	/

Table 5.23 above details the three period patterns for sub-levels of category 11. The most common pattern for the high performing teams and the low performing teams was / (constant increase between periods 1, 2 and 3). This meant that the teams' task communication increased from period 1 to period 2 to period 3.

The high performing teams were different from the low performing groups in their use of sub-categories 11.6 (challenge new proposal), 11.7 (request clarification), 11.10 (resolve problem), 11.11 (identify lack of resources), 11.12 (test planning or carried out). Sub-category 11.12 was the only one that showed differentiating patterns between the high performing groups and the low performing groups.

Table 5.24- Three Period Pattern for Sub-Levels of Category 12 (Goals)

Three Period Pattern for Sub-Levels of Category 12 (Goals)		
Team	**12.1**	**12.2**
H1	/	—
H2	—	∨
H3	/	∧
H4	∧	¬
L1	∧	/
L2	/	/
L3	⌈	/
L4	∨	/

Table 5.24 above details the three period patterns for sub-levels of category 12. The most common pattern for the low performing teams was / (constant increase between periods 1, 2 and 3). This meant that the low performing teams identified most of their goals during the third period. The high performing groups had 3 patterns that had more occurrences than any other pattern. These were / (constant increase between periods 1, 2 and 3), — (steady [no increase or decrease] between periods 1, 2 and 3) and ∧ (growth between period 1 to period 2, then a decrease to period 3). The high performing groups identified most of their goals during different periods.

In sub-category 12.2 (personal goals), the low performing groups had the same pattern of constant growth from periods 1, 2 and 3 but the high performing groups used a different pattern each. In sub-category 12.1 (team goals), the teams again varied in the patterns they used. There were no patterns that differentiated between the high performing groups and the low performing groups.

Result

Of the 91 possible sub-categories, 4 of these showed pattern differences between the high performing teams and the low performing teams. The other sub-categories showed both differences and similarities across all the teams. These differences and similarities were investigated in further analyses in later chapters.

5.7. Organisation of Communication

While analysing each team's communication, it was noticed that the interaction of the high performing teams was well focused, organised and coherent, which made following the **communication threads**[9] much easier to summarise. The communication of the low performing teams was more fragmented and less focused, making it difficult to follow a particular thread from beginning to end. This meant that many decisions in the low performing teams had to be revisited, as it was very common that they were not made clear from the onset.

Appendix 5.3 shows a sample of team interaction from each teams' collection of IRC's. In order to make a fair comparison, it was important to find the beginning of a topic within each IRC.

For all teams, the beginning topic was planning either for the current meeting or for future work.

Each sample contains 32 entries by the individuals in each team.

---

[9] **Communication Threads** – an uninterrupted topic in a team's synchronous communication.

One individual may have contributed more than one line at a time but if someone else 'speaking' does not interrupt the lines then this was be considered one entry. This is represented in the tables in Appendix 5.3 by the use of rows where each row contains one entry.

The samples contain the continuous interactions as per the original transcripts and will therefore include IRC protocol information.

Column 2 of the tables in Appendix 5.3 contains the original transcripts.

Column 1 shows the threads labelled numerically.

Each entry was assigned a thread number. In many cases, the threads did not follow a consecutive pattern but were rather interspersed with other threads.

Because of space limitations only four examples of the threads' summary are listed below but a sample of all 8 teams' threads are available in Appendix 5.3.

<u>H1, a high performing team, had 4 threads.</u>

Thread 1 - introduced the idea of an agenda for the meeting.

Thread 2 - looked for and discussed ideas for the design document.

Thread 3 – discussed the creation of an RMI page for information.

Thread 4 – detailed the partitioning of work.

<u>L3, a low performing team, has 9 threads.</u>

Thread 1 – discussion and posting of a meeting agenda for the current meeting.

Thread 2 - the curiosity and explanation of someone logging into the meeting.

Thread 3 - briefly introduced the idea of using CVS (interrupted by thread 4).

Thread 4 - someone having problems with logging into the system.

Thread 5 - someone outside the group leaving the conversation.

Thread 6 – the creation of a new web site and its vote to become the primary web site constituted.

Thread 7 - the person who was responsible for the next milestone report was named.

Thread 8 - questioned and answered when the video/camera code would be ready.

Thread 9 - suggested the idea of the next meeting.

<u>H4, a high performing team, followed 3 threads.</u>

Thread 1 - introduced and followed a plan for what was to be done during the following week taking into consideration what was due for the next meeting. This consisted of looking at the project calendar and discussion the design issues, which was due to following week.

Thread 2 - an issue being completed from a previous discussion where one person was to complete an information page and place it in a specific place.

Thread 3 - the idea of having a 'common meeting time' for future meetings.

<u>L4, a low performing team, had 8 threads.</u>

Thread 1 - trying to discuss a strategy for the meeting they would soon have with Arnold their tutor.

Thread 2 - An individual trying to let the rest of the team know she had an external exam and would not have time for the project.

Thread 3 - the testing and enhancement of an 'old' program a couple of members were working on (interrupted by thread 4).

Thread 4 - asked if a certain team member was still around.

Thread 5 - planning future meetings with Arnold, the tutor.

Thread 6 - someone was having problems with registering nicknames and was requesting help.

Thread 7 - an idea to a specific team member for updating the applet.

Thread 8 - Arnold, the tutor, joined the meeting and waited until they sorted a few things. The team members acknowledged Arnold in order to begin the meeting

These samples illustrate the observation that the high performing teams were more organised in their communication. The high performing teams had considerably fewer threads than the low performing teams. DeSanctis, *et al* (2001), found that

> *higher performing teams average fewer posted threads, words, and words-per posting on group discussion boards... They prefer fewer but deeper conversations over several shallow conversational topics. They keep in touch, keep in synch, and keep digging deeper as they discuss important issues*

The high performing teams in this project finished a thread before going to the next more often than the low performing teams. The low performing teams often introduced threads in between other threads therefore jeopardising the resolution and completion of existing threads. There were occasions when threads were introduced but not completed or resolved. On other occasions a team member would introduce a new thread and was ignored as one member from team L4 stated,

kind of hard getting people's attention here... (L4 - I19 p.102)

5.7.1. Organised Documentation

It was noted at the beginning of the study that some teams were better organised in the way they documented and archived their communication logs. Some teams archived their email separately from their IRC communication, which in turn made it easier to identify and organise for this study's purpose. Other teams' communication was not as easy to identify because they either placed their files in different places or they put everything including their code into one huge file. In some teams, different members of the team logged the same meetings with different start or end points depending on when they entered or left the meeting. This resulted in the researcher going through different versions of the same meeting to ensure that the communication for the entire meeting was analysed. As Table 4.1, chapter 4 documents, 1 out of the 4 high performing teams had some IRCs missing whereas 3 out of 4 of the low performing teams had some IRCs missing. All IRCs were eventually found as explained in chapter 3. Two of the low performing teams had duplication of logs where none of the high performing teams had disproportionate duplication. Bennatan (2000) states that

badly organised projects breed confusion, and confusion leads to project failure.

This lack of organisation and clarity in the communication made tracking and summarising both interesting and difficult for this study. The communication logs had a dual purpose in the Runestone Project. They were to enable studies such as this for its researchers and they were also to provide the students with a log of their communication such as decisions about their work. It is possible that since this study found tracking and summarising the communication challenging, the students themselves may have also found some problems if they went back to their logs for validation of decisions made during a meeting.

The high performing teams' focused, organised and smaller amounts of communication suggest that they pay more attention to the way they conduct and organise their interactions than the lower performing teams. This could also suggest that the high performing teams' thinking was less chaotic than that of the low performing teams. The fact that the low performing teams had a higher number of communication and decisions (discussed in Chapter 6) than the high performing teams could imply that the high performing teams had less of a particular type of communication.

Figure 5.1 shows that the pattern trend of the percentage usage of categories was similar across all teams. This illustrates that the high performing teams, which had less total communication, had similar percentage use of each category as the low performing teams. The possible implication that there were differences in the percentage use of each communication type between the high performing and the low performing teams was not supported in this research. It is important to note that although this study concentrated on the electronic communication, the face to face communication was also considered via the re-iteration of those conversations during electronic meetings. In the communication logs, the students were very clear about stating conversations they had outside of the electronic meetings.

5.8. Chapter Summary

Of the four issues tested for significance, three issues were shown as highly significant and one was not significant. A summary of the findings indicates that:

The 8 teams used in this study were very different in their total number of communications. This shows that each team communicated (and inferred worked) differently from the other teams.

Significance tests on the distribution of totals within the high and low performing groups showed a highly significant result. As with the results on the distribution of total communication among the 8 teams, the high performing teams tended to make fewer communications than the low performing teams. In looking at how several small teams work and communicate, DeSanctis, *et al* (2001) states that

> *higher performing global learning teams do not necessarily communicate more, or more often, with one another compared to lower performing teams. More important to success is communicating deeply, with focus, and developing routines of communication and task completion.*

Highly significant results indicated that the 8 teams were also very different in their use of Email as opposed to IRC. This reinforces the idea that the teams worked and communicated differently. Possible reasons for this include the technological proficiency of the team members, the leader's management of the group or the commitment of the team members. Dube and Pare (2001) in discussing the leader's responsibility to the group, state

> *Structured communication sessions directed by a formal leader can give every member the time to speak.*

In discussing the commitment of the group, they also state

> *teleconferencing or videoconferencing are much richer than email but require high levels of commitment, flexibility, and discipline on the part of several team members.*

There was no significant difference between the use of Email and IRC between the total high and low performance. In a study that looks at the challenges and coping strategies of global virtual teams, Dube and Pare (2001) show that between teams

> *communication styles differ.*

The significance test did not show that there were significant differences in the use of Email and IRC between the total high and low performing groups. Although the raw data showed differences in the usage of Email and IRC's in the individual high and low performing teams, these differences were not seen as significant and therefore possibly occurred by chance.

Highly significant differences were found in both the distribution of the total communication of all 8 teams and in the distribution between the high and low performing teams. This helped to form the hypothesis that there would be a relationship between the ranking of the total communication and the team average mark (TAM). The result of a correlation test showed that there was no relationship between the two rankings. One explanation for the different results between the differences found where the high performing groups had less communication and the ranking of the communication and the ranking of grades, is that the initial looked for relationship between each team's ranking of communication and grades. The test which resulted in the high performers having less communication looked at the communication of the combined high performing groups.

Investigation of the percent frequency of the communication types showed that all the teams were similar in their use of the top-level categories. Differences between all the teams were found in the frequency of sub-level categories between all the teams. These differences were found in categories C3 (decisions), C8 (graphical expressions), C10 (identification) and C12 (goals).

Investigation of the communication types along the project's three-period timeline, showed differences in the patterns produced by the high performing groups and the patterns produced by the low performing groups. Analysis of the top-level categories showed differences in C3 (decisions), C4 (roles), C5 (conflict) and C9 (ideas). The sub-level categories showed differences between the high performing teams and the low performing teams in sub-categories C1.3, C3.3, C9.1and C11.12. This analysis also showed that the pattern of use across the three periods was $\wedge$ (growth between period 1 to period 2, then a decrease to period 3). This pattern shows that the majority of work was carried out during the second period. The investigation carried out in the communication type was further investigated in the timing of tasks associated with the software development process in Chapter 7.

The differences found between the 8 teams and between the high and low performing groups show that teams work and communicate differently from each other and tend to choose the media for their required need and task. Dube and Pare (2001) state

choosing the right technology to accomplish a task at the right time becomes a matter of survival for global virtual teams.

Chapter 6

Decision-Making

6.1. Introduction

Communication and interaction are important factors in group effectiveness (Hartley, 1997). Poole and Hirokawa (1986) state,

> *The unique chemistry of social interaction can distill the best that each member has to offer, creating a resonance of ideas and a synthesis of viewpoints. A different chemistry can stop the reaction and contaminate the product with erratic reasoning or low commitment. Communication is the catalyst for this social chemistry and, as such, it is widely recognized as a key force in group decision-making*

Chapter 5 began the analyses with an investigation of the use of the communication technology and the types of communication. This chapter details the communication by investigating the decision-making patterns of the teams. Poole and Doelger (1986) believe that interaction is the essence of group decision-making.

> *In a complex interplay and interweaving of ideas, preferences, and perspectives, premises and options are advanced and discredited, goals are proposed and elaborated, actors enter and withdraw from discussions, and decisions are tested, refined, modified and confirmed*
> *(Poole and Doelger, 1986).*

This investigation identified the different types of decisions made and the strategy methods used by the teams. The chapter concludes with a discussion of how patterns identified affect the performance in high performing teams and low performing teams.

6.2. Previous Research Applied to Current Study

The current study looks at the communication in both email and IRC format for the 4 high performing teams and 4 low performing teams previously identified in Chapter 4. The communication of each team was studied for evidence of decision structures during the group's decision-making process throughout the project's life cycle. Communication in this study was viewed as both the **medium** of group interaction therefore acknowledging it as a tool for decision-making and as **constitutive** of group decisions. This research employed observation-based techniques from the qualitative methodology of inductive analysis (explained in Chapter 4) in identifying decisions in each team's communication.

Looking at the form and content of decisions through communication (**constitutive**), this study identified group decisions as goal-oriented or activity-oriented. **Goals** in this context were defined as the weekly set deliverables or the successful completion of the product. A decision was identified as **goal-oriented** if the content and form of the communication dealt with a set deliverable or the final product - for example, decisions made for the control motor (week 3 deliverable). An **activity-oriented** decision was one that dealt with particular activity not necessarily related to a goal or deliverable - for example, a decision made on the choice of communication medium for the next meeting.

The **problem-solving task**, the set deliverables and deadlines were identical for all teams. However, the task representation differed from team to team as the team make-up also differed from team to team. Not only did some teams differ in size but they also differed in experience, commitment, group polarisation, working habits, leadership styles and motivation. These factors were measured in this study via the team profile. The creation of the team profile is explained in section 4.8 and the outcome is explained in chapter 8.

These factors may have helped or hindered the team's decision-making development (Poole and Hirokawa, 1986; Hartley, 1997).

This study took into account Poole and Doelger's (1986) three possible complications:

- The differences between individual and collective task representation.
- The lack of completion or clarity in task representation.
- Possible changes of individual and collective task representation over time.

Taking into account the three possible complications, this study identified decisions as explicit or implicit. **Implicit decisions** were identified when actions were taken but a decision to take that action had not been made during a team meeting. **Explicit decisions** were identified when actions were taken because of a decision made during a team meeting. Decisions were also tracked along the project's timeline, which helped to overcome the complication of decision changes with time.

Other factors considered in the identification of each team's decision structure were:

- Was the decision made by the individual who proposed it or by the whole or partial group?
- Was it always the same person proposing and/or making the decisions for the group?
- Was the decision challenged or just accepted?
- What current method, as per Table 6.1 below, was being used and does this method stay consistent throughout the project life or did it change?

Table 6.1 - Decision-Making Methods (Hartley, 1997)

	Method	Advantage	Disadvantage
M1	Decision by authority without discussion.	Speed.	Does not use members' expertise.
M2	Decision by authority after discussion.	Allows everyone to express opinion.	Members may not be committed to the decision.
M3	Decision by expert member.	Good decision if really expert.	May be difficult to identify the most expert member.
M4	Average members' opinions.	Speed.	Members may not be committed to the decision.
M5	Majority control.	Speed.	Minority can be alienated.
M6	Minority control.	Can be useful if not everyone can attend.	Members may not be committed to the decision.
M7	Consensus.	Members will be committed to the decision.	Can take a great deal of time, skill and energy.

6.3. Analyses Design

In order to standardise the interaction a summary of each team's communication was compiled (example is shown in Figure 6.1). Themes or threads such as design discussion, social interaction, friendly joking, etc. were identified during each communication instance and electronically documented as a summary for the team's communication. This facilitated the flagging of decisions types and the total number of decisions per team.

The patterns found in this investigation were derived from quantitative and qualitative analysis. The quantitative analyses involved significance or standard deviation tests as used in Chapter 5. The qualitative analyses involved observation of each team's decision-making process via their communication.

Types of decisions were identified as **implicit** or **explicit** and **goal-oriented** or **activity-oriented.**

An example of an explicit decision is:

> *we create a 'path matrix'... a path matrix sounds good...that consists of a plane of vectors... (L2 - I7 - p.25).*

An example of an implicit decision is:

I see you made small change to the PathDrawCanvas class in the constructor to enable/disable drawing...I also made another change in another copy of that same class... (H1 - I54 - p.143).

An example of a goal-oriented decision that dealt directly with the control motor (week 3 deliverable) is as follows:

I've been writing some code for the motor which I think would work... (L1 - I2 - p.2).

An example of an **activity-oriented** decision is as per the example below. This decision dealt with the choice of communication tool for the next meeting or where to place the files.

I'm going to move all the java class source code (.java) into the {srcdir}/Brio directory so the java compiler and tools are happy...(H2 - E83 - p.59)*

Having identified decisions by types, i.e. implicit/explicit, goal/activity, this research also looked at whether or not the decision was **challenged** or **agreed**. **Challenged decisions** were identified when a decision was initiated or made and thereafter followed a discussion contradicting or disagreeing with the decision. An example of a challenged decision is as follows:

the PID determines where the ball is now compared to the destination point...(c) what if it isn't a straight path...(a) it then makes corrections to move the board to where it should end up...(c) how can you do comparision with one current point?...destination point = The next point onthe path right?...(a) the pid only calcutes from it current point to the destination point...(c) What is 'destination point'??? The next point in the path? (H3 - I7 - p. 37).

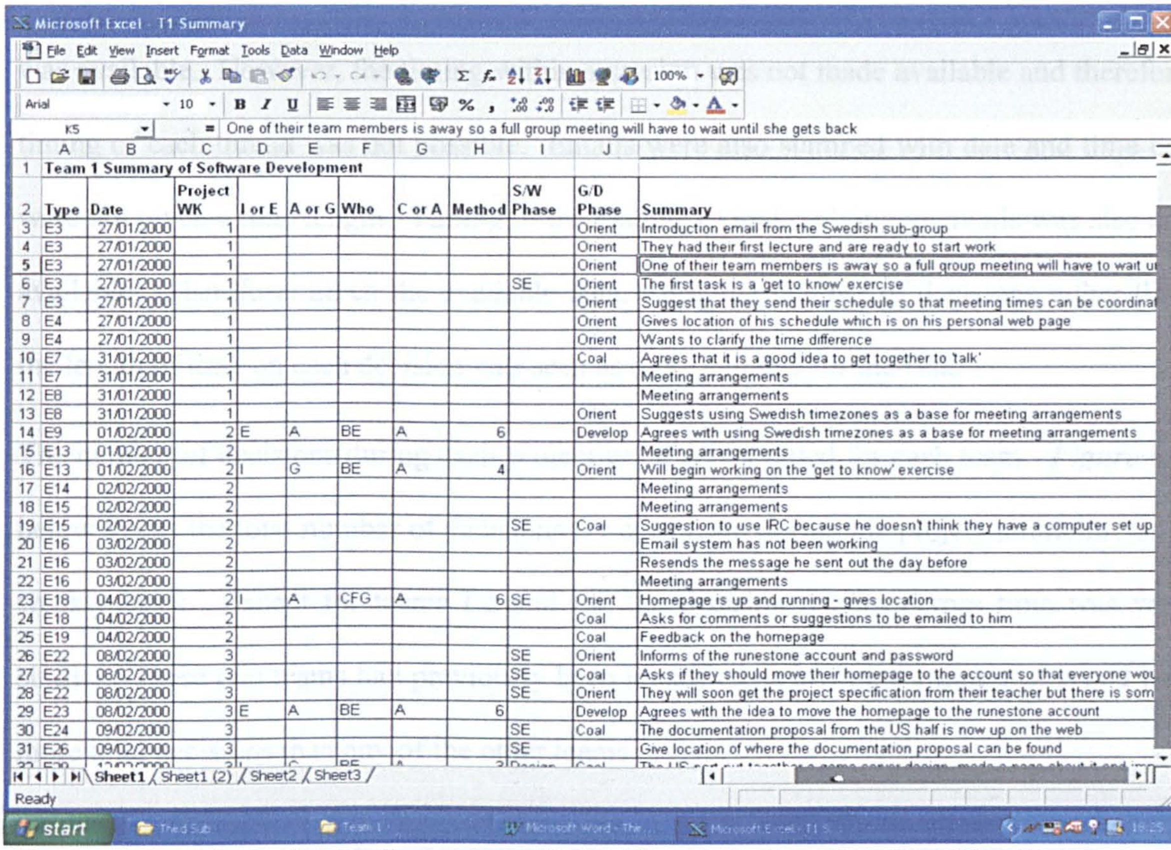
An **agreed decision** was identified when there was 'silence' after the decision was made, implying agreement or when there was an agreement voiced without any disagreements or explicit arguments.

why don't you make it our primary web-site...(a) ok if that is ok for everyone...(a) you get my vote...(a) mine too... (L3 - I24 - p.53)

Researcher's note - the (c) in the challenge example quote stands for a challenge by another team member and the (a) stands for the answer given by the initiator as a response to the challenge. All wording has been kept true to the original text including any misspellings.

Decisions were identified with an 'E' for explicit or 'I' for implicit and 'G' for a goal-oriented decision or 'A' for an activity-oriented decision. The documentation summary included

- the decision identification
- the summary theme (thread)
- the date
- the type (I-IRC or E-email)
- the corresponding project week
- the corresponding software development phase (Chapter 7)
- the corresponding group development phase (Chapter 8)
- the initials of the decision initiator
- whether or not the decision was challenged (C) or accepted (A)
- the number corresponding to the method as per Table 6.1.



Team 1 Summary of Software Development

Type	Date	Project WK	I or E	A or G	Who	C or A	Method	S/W Phase	G/D Phase	Summary
E3	27/01/2000	1							Orient	Introduction email from the Swedish sub-group
E3	27/01/2000	1							Orient	They had their first lecture and are ready to start work
E3	27/01/2000	1							Orient	One of their team members is away so a full group meeting will have to wait u
E3	27/01/2000	1						SE	Orient	The first task is a 'get to know' exercise
E3	27/01/2000	1							Orient	Suggest that they send their schedule so that meeting times can be coordinat
E4	27/01/2000	1							Orient	Gives location of his schedule which is on his personal web page
E4	27/01/2000	1							Orient	Wants to clarify the time difference
E7	31/01/2000	1							Coal	Agrees that it is a good idea to get together to 'talk'
E7	31/01/2000	1								Meeting arrangements
E8	31/01/2000	1								Meeting arrangements
E8	31/01/2000	1							Orient	Suggests using Swedish timezones as a base for meeting arrangements
E9	01/02/2000	2	E	A	BE	A	6		Develop	Agrees with using Swedish timezones as a base for meeting arrangements
E13	01/02/2000	2								Meeting arrangements
E13	01/02/2000	2	I	G	BE	A	4		Orient	Will begin working on the 'get to know' exercise
E14	02/02/2000	2								Meeting arrangements
E15	02/02/2000	2								Meeting arrangements
E15	02/02/2000	2						SE	Coal	Suggestion to use IRC because he doesn't think they have a computer set up
E16	03/02/2000	2								Email system has not been working
E16	03/02/2000	2								Resends the message he sent out the day before
E16	03/02/2000	2								Meeting arrangements
E18	04/02/2000	2	I	A	CFG	A	6	SE	Orient	Homepage is up and running - gives location
E18	04/02/2000	2							Coal	Asks for comments or suggestions to be emailed to him
E19	04/02/2000	2							Coal	Feedback on the homepage
E22	08/02/2000	3						SE	Orient	Informs of the runestone account and password
E22	08/02/2000	3						SE	Coal	Asks if they should move their homepage to the account so that everyone wou
E22	08/02/2000	3						SE	Orient	They will soon get the project specification from their teacher but there is som
E23	08/02/2000	3	E	A	BE	A	6		Develop	Agrees with the idea to move the homepage to the runestone account
E24	09/02/2000	3						SE	Coal	The documentation proposal from the US half is now up on the web
E26	09/02/2000	3						SE		Give location of where the documentation proposal can be found

Figure 6.1 - Example of a Summary of Each Team's Interaction (Decision Types, Software Development Process and Group Development Process)

Figure 6.1 shows an example of a team's summary of interaction. As explained at the beginning of section 6.3, the summary logs each team's decision types, software development process and group development process. This logged information aided in the analysis and tracking over time of decision types, software development phases and group development phases.

6.4. Total Number Of Decisions

The summaries of the email and IRC communication were compiled according to the threads (topics) observed in each IRC meeting or email. Threads were identified and documented according to the number of times they occurred in each communication rather than the length of time each thread took in the discussion. The session start and end times were initially logged with each IRC communication so the timing of an entire IRC meeting was available. However, the timing within a session was not made available and therefore timing of each thread was not possible. Emails were also stamped with date and time but were not given a time length. Timing of the reading of and replying to emails was also not available. Therefore, given the available data, using the number of decisions rather than the length of time on each decision was seen as more suitable for the task.

The number of decisions during each project week was totalled for each team. ***Figure 6.2*** below tracks the total number of decisions for each team during the project's timeline on a weekly basis. Except for teams L2 and L4, the decision pattern across time was very similar. These two teams had previously been identified as low performing teams and had more total decisions than any of the other teams.

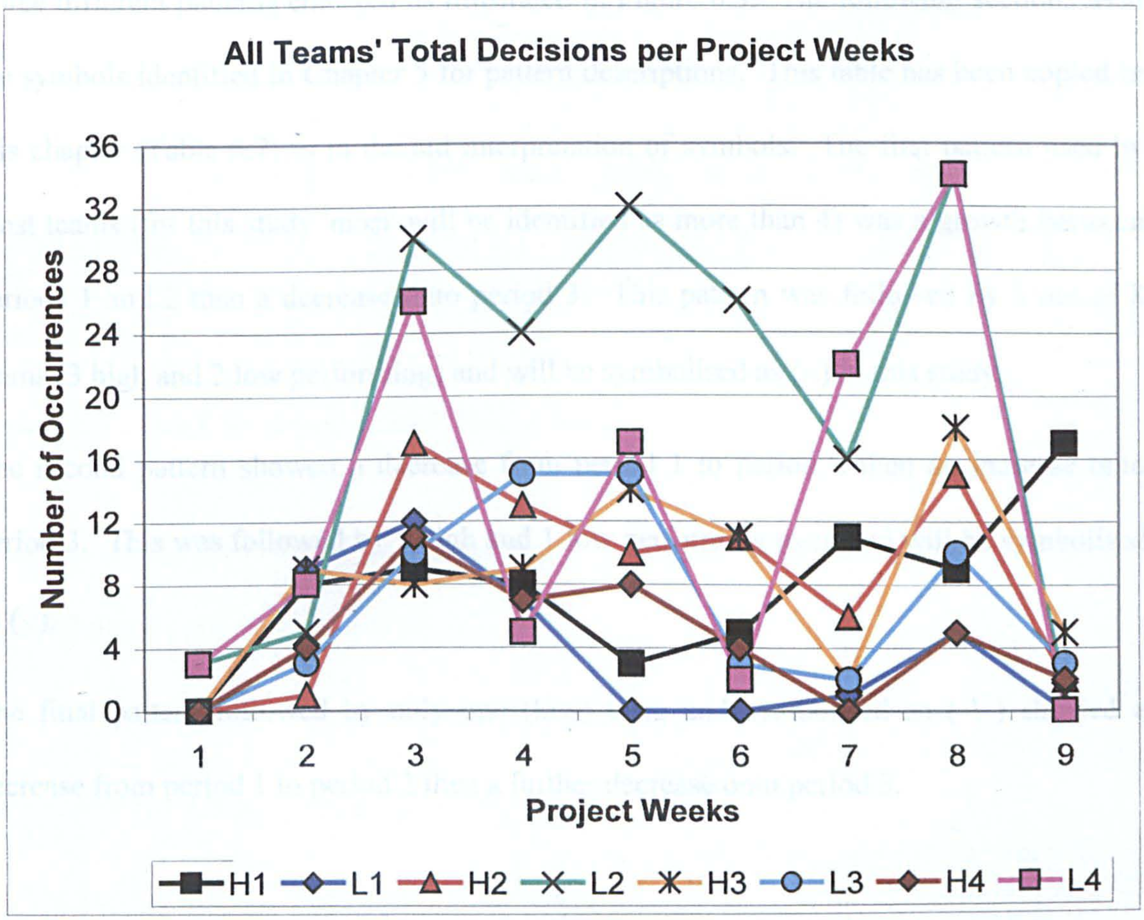


Figure 6.2 - All Teams Total Decisions per Project Weeks

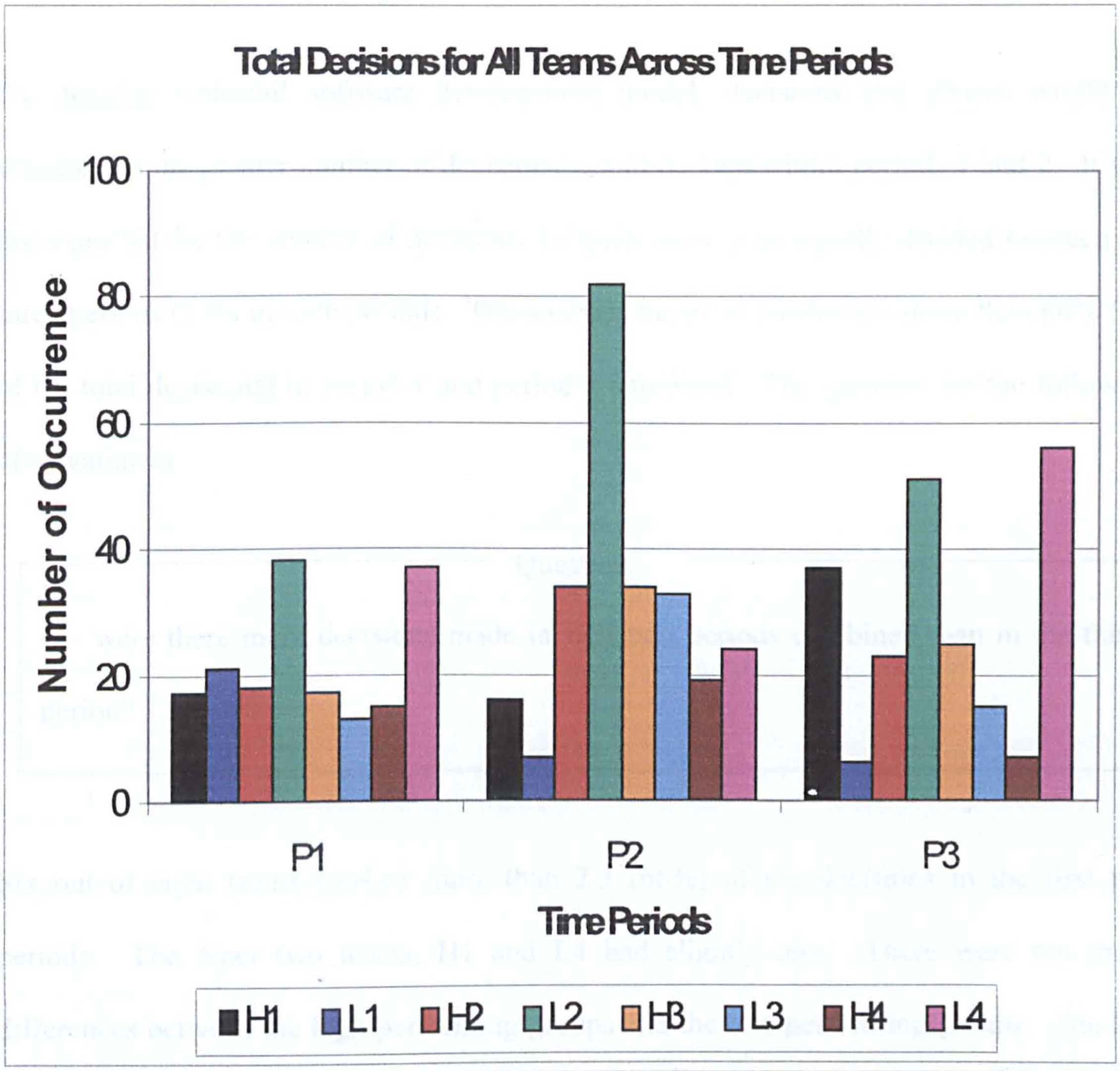
Although teams L2 and L4 showed specific peaks during certain weeks, it was very difficult to identify specific patterns. Analysis looked for decision-making patterns throughout time periods that reflected the software development lifecycle. The software development for each team is discussed in further detail in Chapter 7.

- **Period 1 (P1)** - encompassed the first three weeks, which had as deliverables: the project introduction (week 1), team building (week 2) and the design documentation (week 3).
- **Period 2 (P2)** - took into account weeks 4, 5 and 6. The deliverables for these weeks were motor controller (week 4), video processor (week 5) and server/project progress (week 6).
- **Period 3 (P3)** - accounted for the last three weeks, which had as deliverables the client communication/client server (week 7), and the final presentation (weeks 8 and 9).

Three different patterns emerged as illustrated in Figure 6.3. The following sections used the symbols identified in Chapter 5 for pattern descriptions. This table has been copied in this chapter (Table 6.7) to in the aid interpretation of symbols. The first pattern used by most teams (for this study 'most' will be identified as more than 4) was a growth between periods 1 and 2 then a decrease onto period 3. This pattern was followed by 5 out of 8 teams (3 high and 2 low performing) and will be symbolised as (∧) in this study.

The second pattern showed a decrease from period 1 to period 2 then an increase onto period 3. This was followed by 1 high and 1 low performing team and will be symbolised as (∨).

The final pattern followed by only one (low) team and symbolised as **(\ )** showed a decrease from period 1 to period 2 then a further decrease onto period 3.



TEAMS	H1	L1	H2	L2	H3	L3	H4	L4
Percentage of Total Number of Decisions per Period								
P1 and P2	47%	82%	69%	70%	67%	75%	83%	52%
P 3	53%	18%	31%	30%	33%	25%	17%	48%

Figure 6.3 - Total Decisions Across Time Periods

In terms of the software development using the waterfall lifecycle model, the work required in the periods translates to:

Period 1 (P1) - system engineering, analysis and design.

Period 2 (P2) - design, coding and testing.

Period 3 (P3) - coding, testing and maintenance.

Because of the nature of the tasks involved in the waterfall software development, more decisions were expected during the analysis and design stages in period 1. However, using the iterative waterfall software development model, decisions and phases would be revisited so the greater number of decisions would be kept within periods 1 and 2. It was not expected for the number of decisions for each team to be equally divided between the three periods (33% in each period). The analysis therefore looked for more than 66% (2/3 of the total decisions) in period 1 and period 2 combined. The question for the following observation is

Question

Q:- were there more decisions made in first two periods combined than in the third period?

Six out of eight teams totalled more than 2/3 (66%) of the decisions in the first two periods. The other two teams, H1 and L4 had slightly less. There were not many differences between the high performing groups and the low performing groups. The low performing groups with the exception of L4 stayed between 70% and 83% for periods 1 and 2 combined. The high performing teams were more varied. Two teams (H2 and H3) stayed between 65% and 70% while H1 dipped at 47% and H4 was at the top end with 83% in the first two periods. Only one team (H1) had more than 50% of the decisions in period 3.

Result

The findings showed that the majority of teams made more than 2/3 (66%) of the total decisions within the first two periods.

These findings are consistent with early analyses on each team's communication where the most common pattern (∧) saw a rise in communication between periods one and two and a drop onto period 3. This analysis will also be investigated in the software development process in Chapter 7.

6.4.1. Comparison of The Spread of Total Number of Decisions

Previous analyses (Chapter 5) showed differences in the distribution of total communication between all the teams and between the high performing teams and the low performing teams. It was therefore assumed that there would be differences in the total number of decisions made between the high performing teams and the low performing teams. A comparison of the spread of total decisions was undertaken to identify any possible differences in the total number of decisions between the high performing teams and the low performing teams. The null hypothesis (*Ho*) for this test is:

Null Hypothesis

Ho: there were no differences in the spread of total number of decisions between the high performing teams and the low performing teams.

Table 6.2 below shows the calculation and results of the Standard Deviation Measure that was used to look at the spread or variation of the decision values within the high performing teams and within the low performing teams.

The formula used is $S = \sqrt{\sum d^2 / N-1}$

Where:

S = Standard Deviation

d^2 = deviation from mean (average)

N = Number of teams

Table 6.2 - Total Decisions Throughout Entire Project Timeline

High Performing Teams				
Team No.	**Total Decisions**	**Mean (average)**	**Deviation (d)**	**Squared Deviation (d^2)**
H3	76	65.5	10.5	110.25
H2	75	65.5	9.5	90.25
H1	70	65.5	4.5	20.25
H4	41	65.5	-24.5	600.25
Total High	262	$S = \sqrt{821.00/4-1}$ = **16.54**		
Low Performing Teams				
L2	171	95.75	75.25	5662.56
L4	117	95.75	21.25	451.56
L3	61	95.75	-34.75	1207.56
L1	34	95.75	-61.75	3813.06
Total Low	383	$S = \sqrt{1134.74/4-1}$ = **60.92**		

Results showed the spread or variance in the high performing teams at 16.54 and in the low performing teams at 60.92. The spread of totals within the high performing teams was less spread than the spread of totals within the low performing teams.

Result

The null hypothesis (*Ho*) in this test was not supported. The findings showed differences in the spread of total number of decisions between the high performing teams and the low performing teams.

Although this shows an interesting spread especially among the low performing groups, a significance test was carried out on the distribution of the total number of decisions amongst all 8 teams (section 6.4.2). A further significance test was also carried out on the distribution of the total number of decisions within the high performing groups and the low performing groups (see section 6.4.3). The purpose of these tests was to identify any statistically significant differences between the totals of all 8 teams and between the total of the high performing groups and the total of the low performing groups.

6.4.2. Distribution Of Total Number Of Decisions for all Teams

Analyses in Chapter 5 showed significant differences in the total number of communication between all teams. It was assumed that there would also be differences in the total number of decisions between all teams. A Chi-Square Test (χ^2) (as explained in Chapter 5) was used to test the hypothesis. The null hypothesis (*Ho*) for this test is:

Null Hypothesis

Ho: there were no significant differences in the total number of decisions within all 8 teams.

This test looks at only one variable, the total number of decisions, so the *Goodness of Fit* test (explained earlier in chapter 5) was used.

The *observed frequencies* (O) (column 2).

The *expected frequencies* (E) (column 3) were calculated as 645/8 = 80.6.

The *degrees of freedom* were calculated as *(k = 8)*, 8-1 = 7.

Table 6.3 below shows the test results.

Table 6.3 - Distribution of Total Number of Decisions within Individual Teams

Team No.	Total (O)	Total (E)	Chi-Square Test (χ^2)
H1	70	80.6	1
L1	34	80.6	27
H2	75	80.6	0
L2	171	80.6	101
H3	76	80.6	0
L3	61	80.6	5
H4	41	80.6	19
L4	117	80.6	16
			Chi-Square Total
Total	**645**		**171**

The Chi-Square Test (χ^2) result is 171 with 7 *degrees of freedom*.

Result

The result was **highly significant** $p < 0.001$. The null hypothesis (*H0*) in this test was not supported. The eight teams studied were very different in their total number of

6.4.3. Distribution Of Total Number Of Decisions for the High Performing Groups and the Low Performing Groups

Previous analyses (Chapter 5) showed that differences between the amount of communication between all teams was because the high performing teams had less communication than the low performing teams. The significance test in section 6.4.2, showed differences in the amount of decisions between all the teams. It was therefore assumed there would also be differences in the total decisions between the high performing groups and the low performing groups. A Chi-Square Test (χ^2) (as explained in Chapter 5) was used to test the hypothesis. The null hypothesis (*Ho*) for this test is:

Null Hypothesis

Ho: there was no significant difference in the total number of decisions between the high performing groups and the low performing groups.

This test, just as the previous test, looks at only one variable, the total number of decisions, so the *Goodness of Fit* test was used.

The observed frequencies (O), column 2.

The *expected frequencies* (E), column 3 were calculated as 645/2 = 322.5.

The *degrees of freedom* was calculated as $k = 2$, 2-1 = 1.

Table 6.4 below shows the test results.

Table 6.4 - Distribution of Performance Totals for High and Low Performing Groups

Team Performance	Total (O)	Total (E)	Chi-Square Test (χ^2)
High Total	262	322.5	11.35
Low Total	383	322.5	11.35
Total	**645**		**Chi-Square Total – 23**

The Chi-Square Test (χ^2) result was 23 with 1 *degrees of freedom.*

Results

The result was **highly significant** $p < 0.001$. The null hypothesis (*H0*) in this test was not supported. The results show that one possible reason for the difference among the eight teams was that the high performing teams tend to make fewer decisions than the low performance teams.

6.4.4. Correlation Tests for Total Average Mark (TAM), Total Communication and Total Decisions

In chapter 5, a correlation test was conducted to test any possible relationship between the ranking of the amount of communication and the ranking of the team average mark (TAM). The results showed no relationship. Two further correlation tests were conducted to look at a type of communication, in this case decisions rather than the total amount of communication against the teams' performance. The first test looked for any possible relationships between the ranking of the total number of decisions and the ranking of the team average mark (TAM). The second test then looked at the total number of decisions and the ranking of total communication for each team. Both tests use Spearman's ρ (rho) as previously discussed in Chapter 5. The null hypothesis (*Ho*) for the first test 1 is:

Null Hypothesis

Ho: there was no relationship between the total number of decisions and the team average mark (TAM).

Table 6.5 below shows the data set up as required by Spearman's ρ (rho).

Table 6.5 - Total Decision Ranking Compared with TAM

Team No.	Tot Dec	TAM	Tot Dec Rank	TAM Rank	Difference between ranks (d)	Diff-Squared (d^2)
H1	70	4.83	5	4	1	1
L1	34	3.06	8	8	0	0
H2	75	4.86	4	3	1	1
L2	171	3.56	1	7	-6	36
H3	76	4.97	3	1	2	4
L3	61	3.67	6	6	0	0
H4	41	4.89	7	2	5	25
L4	117	3.8	2	5	-3	9
						Total (Σd^2) = 76

The correlation coefficient was calculated giving the result of 0.095. This obtained value was looked up in the *significance table* (Appendix 5.2) of the critical values of Spearman's ρ.

Results

The result was **not significant** with $p > 0.50$. The null hypothesis (*H0*) in this test was supported. The results show NO relationship between the team average mark (TAM) ranking and the ranking of total number of decisions.

The null hypothesis (***Ho***) for the second test is:

Null Hypothesis

Ho: there was no relationship between the total number of decisions and the total communication.

Table 6.6 below shows the data set up as required by Spearman's ρ (rho).

Table 6.6 - Total Decision Ranking Compared with Total Communication

Team No.	Comm Tot	Tot Dec	Com Rank	Tot Dec Rank	Difference between ranks (d)	Diff-Squared (d^2)
H1	2876	70	5	5	0	0
L1	1599	34	8	8	0	0
H2	2851	75	6	4	2	4
L2	8519	171	1	1	0	0
H3	2725	76	7	3	4	16
L3	3015	61	4	6	-2	4
H4	4960	41	2	7	-5	25
L4	4526	117	3	2	1	1
						Total (Σd^2) = 50

The correlation coefficient was calculated giving the result of 0.405. This obtained value was looked up in the *significance table* of the critical values of Spearman's ρ.

Result

The result was **not significant** with $p > 0.50$. The null hypothesis (*H0*) in this test was supported. The results show NO relationship between the total communication ranking and the ranking of total number of decisions.

6.5. Decisions Types Across Time Periods

Analyses carried out in section 6.4 showed that when looking at the total decisions made by each of the teams across the 9-week duration, there were two teams that peaked above others in total decisions during some weeks. Looking at the total decisions per team across a three-time period showed three different patterns of use. This analysis also showed that most teams had more of their total decisions during the first two periods. The following sections (6.5.1, 6.5.2, 6.5.3) looked for patterns across the three-time period for each of the decision types identified in section 6.3.

The following sections used the symbols identified in Chapter 5 for pattern descriptions. The table has been repeated below to aid the interpretation of the symbols.

Table 6.7 – Copy of Symbol Chart Representing Direction from Period to Period

Pattern Symbol	Pattern Description
∧	Growth between period 1 to period 2, then a decrease to period 3.
∨	Decrease between period 1 to period 2 then a growth again to period 3.
/	Constant increase between periods 1, 2 and 3.
\	Constant decrease between periods 1, 2 and 3.
¬	Remain constant between periods 1 and 2 but decreases onto period 3.
⌋	Remain constant between periods 1and 2 but increases onto period 3.
⌊	Decrease between periods 1and 2 then remained constant to period 3.
⌈	Increase between periods 1and 2 then remained constant to period 3.
—	Steady (no increase or decrease) between periods 1, 2 and 3.

6.5.1. Explicit and Implicit Decisions Across Time Periods

The implicit (Figure 6.4) and explicit (Figure 6.5) decisions were looked at in terms of the three-time periods that relate to the software development process. This analysis looked for patterns of use in the implicit and explicit decisions that differentiate between the high performing groups and the low performing groups. It also looked for the greater number of decisions made by all teams during the first two periods. In the implicit and explicit decisions made across the three-time periods, this analysis looked for differences between the high performing groups and the low performing groups. There were six questions for this observation.

Questions

***Q*- 1** were there differences between the high performing groups and the low performing groups in the use of implicit decisions?

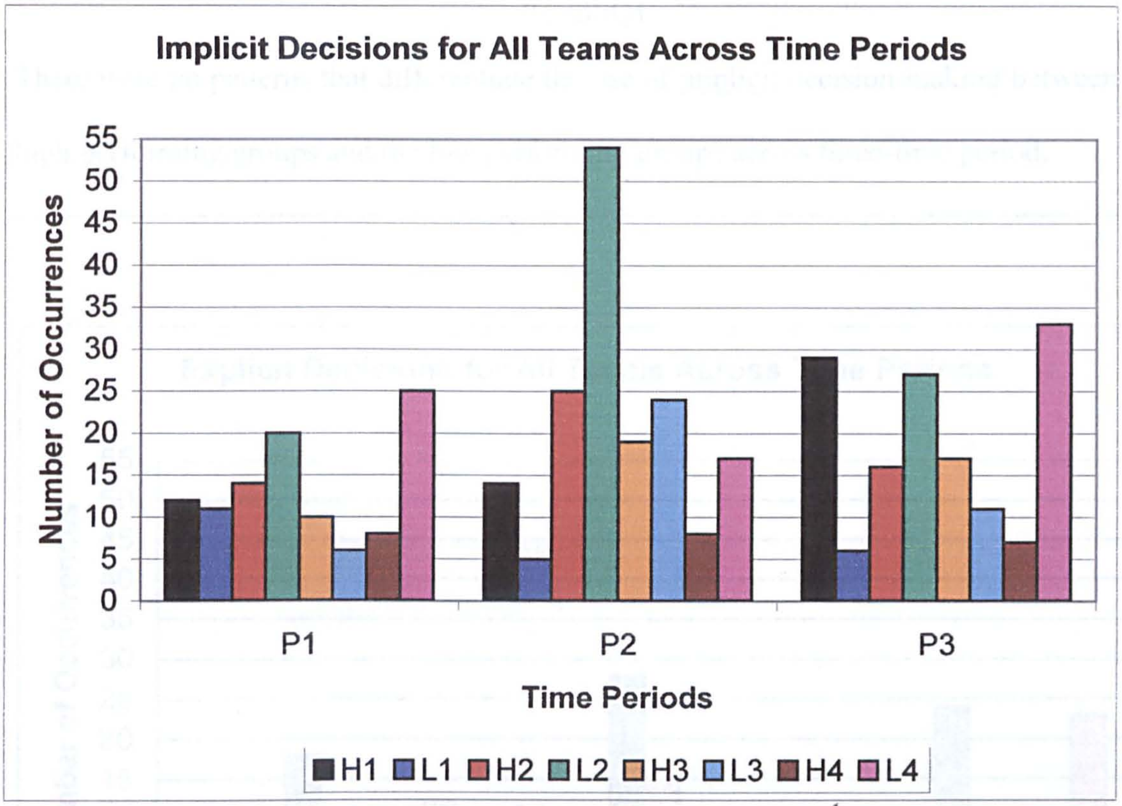
***Q* - 2** were there differences between the high performing groups and the low performing groups in the use of explicit decisions?

***Q* - 3** were there more implicit decisions made in first two periods combined than in the third period?

***Q* - 4** were there more explicit decisions made in first two periods combined than in the third period?

***Q* - 5** was there a difference between the high performing groups and the low performing groups in the timing of implicit decisions made in the first two periods as opposed to the third period?

***Q* - 6** was there a difference between the high performing groups and the low performing groups in the timing of explicit decisions made in the first two periods as opposed to the third period?



WEEK	H1	L1	H2	L2	H3	L3	H4	L4
Percentage of total number of implicit decisions.								
P 1 and 2	47%	73%	71%	73%	63%	73%	70%	56%
P 3	53%	27%	29%	27%	37%	27%	30%	44%

Figure 6.4 - Implicit Decisions for All Teams Across Time Periods

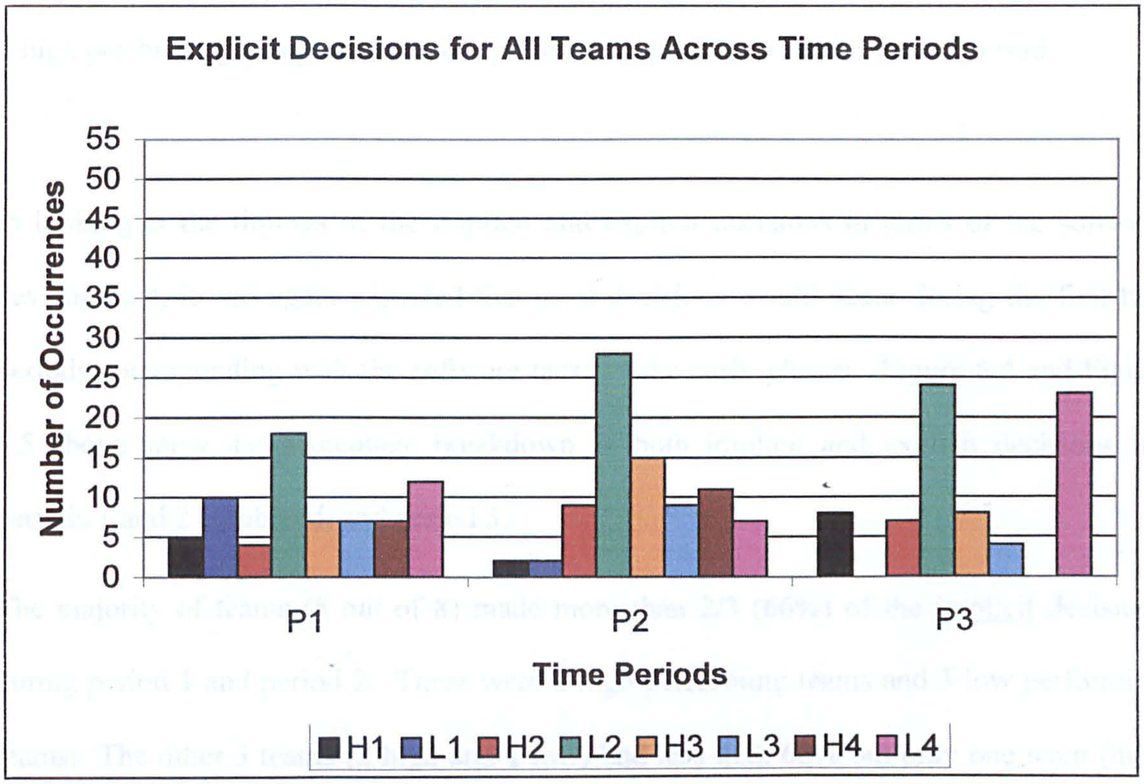
Looking at the teams' implicit decisions in terms of the three-time periods, the high peaks of team L4 were not as significant as previously seen during the individual weeks. L2 however, still shows a very high peak during the second period. Four patterns emerged.

Pattern Description	**Pattern Symbol**	**Number of Teams**	
		High Performing	**Low Performing**
Growth between period 1 to period 2, then a decrease to period 3	ʌ	2	2
Decrease between period 1 to period 2 then a growth again to period 3	v	0	2
Constant increase between periods 1, 2 and 3	/	1	0
Remain constant between periods 1 and 2 but decreases onto period 3	¬	1	0

Note: See Table 6.7 for definition of symbols.

Result Q1

There were no patterns that differentiate the use of <u>implicit</u> decision-making between the high performing groups and the low performing groups across three-time period.



WEEK	H1	L1	H2	L2	H3	L3	H4	L4
P 1 and 2	47%	100%	65%	66%	73%	80%	100%	45%
P 3	53%	0%	35%	34%	27%	20%	0%	55%

Figure 6.5 - Explicit Decisions for All Teams Across Time Periods

The explicit decisions revealed three different patterns.

Pattern Description	**Pattern Symbol**	**Number of Teams**	
		High Performing	**Low Performing**
Growth between period 1 to period 2, then a decrease to period 3	^	3	2
Decrease between period 1 to period 2 then a growth again to period 3	v	1	1
Constant decrease between periods 1, 2 and 3	\	0	1

Note: See Table 6.7 for definition of symbols.

Although the majority of the high performing teams had more explicit decisions during the second period, half of the low performing teams had the same pattern.

Result Q2

There were no patterns that differentiate the use of explicit decision-making between the high performing groups and the low performing groups across three-time period.

In looking at the timings of the implicit and explicit decisions in terms of the software development, it was again expected that most decisions would occur during the first two periods corresponding with the software tasks in the early phases. Figure 6.4 and Figure 6.5 above show the percentage breakdown of both implicit and explicit decisions for periods 1 and 2 combined, and period 3.

The majority of teams (5 out of 8) made more than 2/3 (66%) of the implicit decisions during period 1 and period 2. There were 2 high performing teams and 3 low performing teams. The other 3 teams (2 high and 1 low) had less than 66% but only one team (high performing) had more than 50% in period 3. The results for analyses 3 and 5 are:

Result Q3

The majority of teams had more implicit decisions made in first two periods combined than in the third period.

Result Q5

There was no difference between the high performing groups and the low performing groups in the timing of implicit decisions made in the first two periods as opposed to the third period.

As in the previous analysis, 5 out of 8 teams made more than 2/3 (66%) of the explicit decisions during period 1 and period 2. These again were 2 high performing teams and 3 low performing teams. The other 3 teams (2 high and 1 low) had less than 66% but 2 of these teams (one high performing and one low performing) had more than 50% in period 3. The results of analyses 4 and 6 are:

Result Q4

The majority of teams had more explicit decisions made in first two periods combined than in the third period.

Result Q6

There was no difference between the high performing groups and the low performing groups in the timing of explicit decisions made in the first two periods as opposed to the third period.

6.5.2. Goal-Oriented and Activity-Oriented Decisions Across Time Periods

The goal-oriented (Figure 6.6) and activity-oriented (Figure 6.7) decisions were looked at in terms of the three-time periods that relate to the software development process. As with the implicit and explicit decisions, this analysis looked for patterns of use in the goal-oriented and activity-oriented decisions that differentiate between the high performing groups and the low performing groups. As stated previously, the early stages of the waterfall software lifecycle require a certain amount of discussion to ascertain the requirements. It was assumed that the majority of decisions had been made in the first two periods. This analysis therefore looked for the greater number of decisions made by all teams during the first two periods. In the goal-oriented and activity-oriented decisions made across the three-time periods, this analysis also looked for differences between the high performing groups and the low performing groups. As with the analysis in section 6.5.1, there are six questions for this observation.

Questions

***Q*- 1** were there differences between the high performing groups and the low performing groups in the use of goal-oriented decisions?

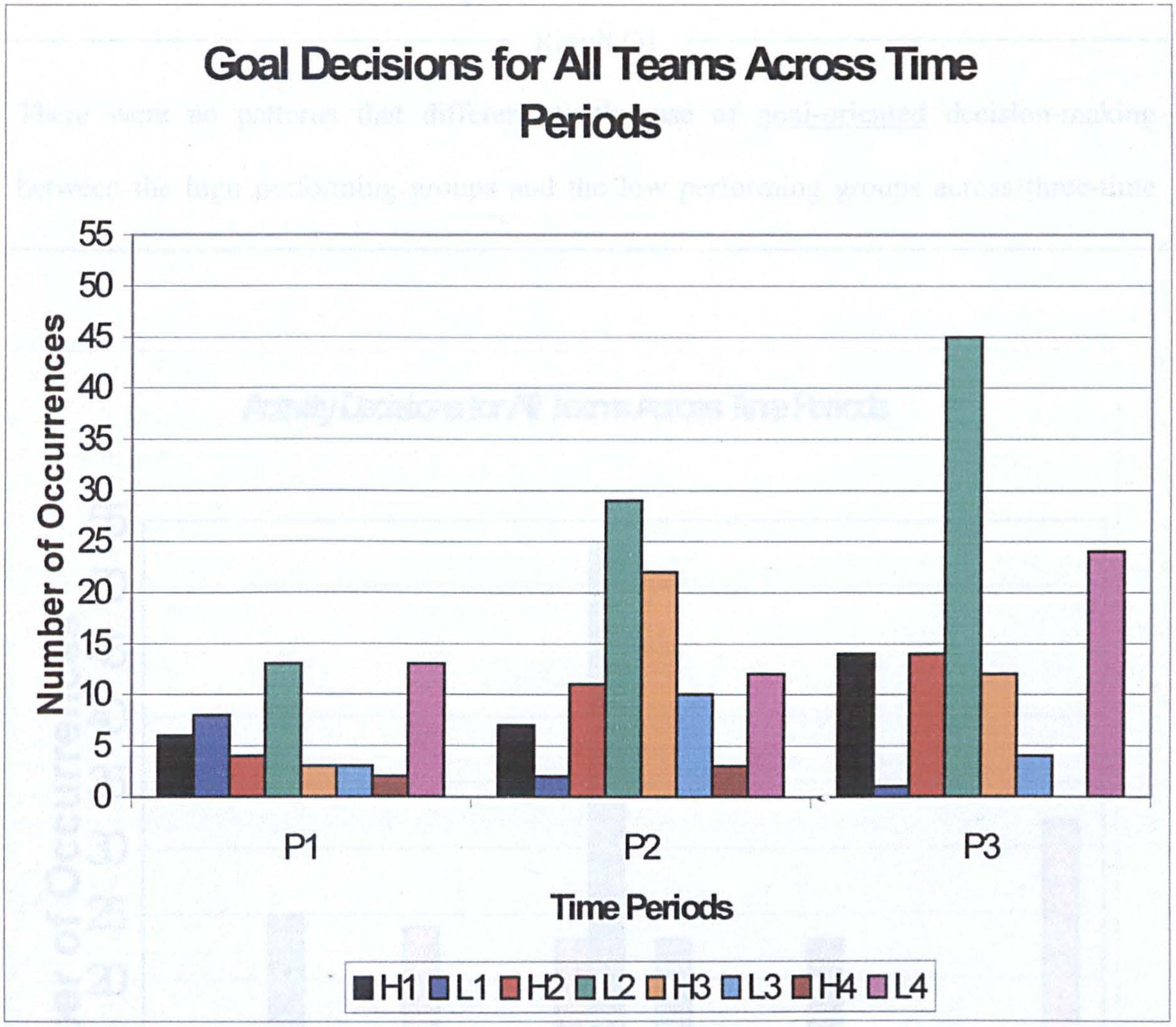
***Q* - 2** were there differences between the high performing groups and the low performing groups in the use of activity-oriented decisions?

***Q* - 3** were there more goal-oriented decisions made in first two periods combined than in the third period?

***Q* - 4** were there more activity-oriented decisions made in first two periods combined than in the third period?

***Q* - 5** was there a difference between the high performing groups and the low performing groups in the timing of goal-oriented decisions made in the first two periods as opposed to the third period?

***Q* - 6** was there a difference between the high performing groups and the low performing groups in the timing of activity-oriented decisions made in the first two periods as opposed to the third period?



WEEK	H1	L1	H2	L2	H3	L3	H4	L4
P 1 and 2	48%	91%	52%	48%	68%	76%	100%	51%
P 3	52%	9%	48%	52%	32%	24%	0%	49%

Figure 6.6 – Goal-oriented Decisions for All Teams Across Time Periods

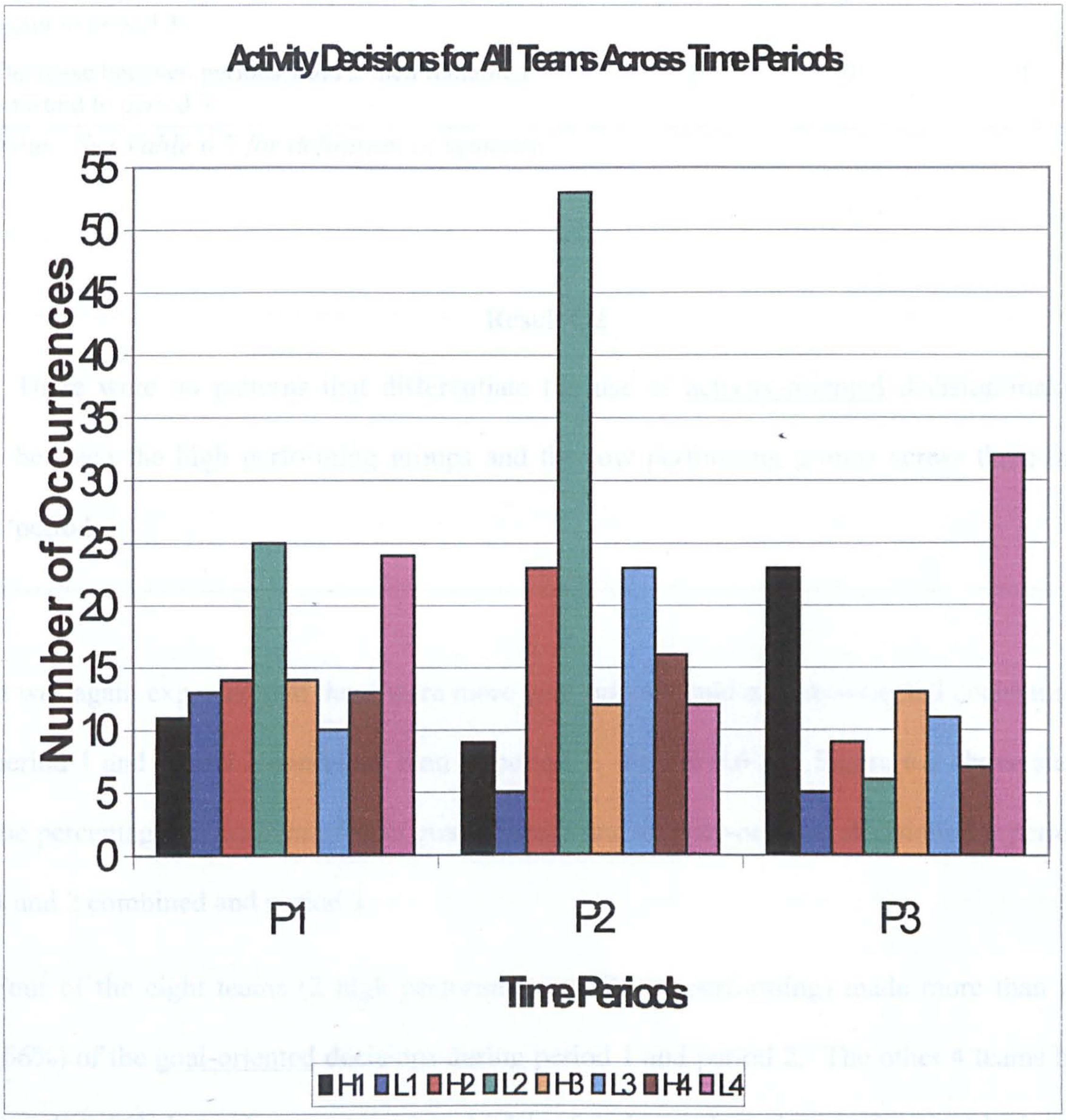
Four patterns emerged when analysing the use of goal-oriented decisions across three-time periods.

Pattern Description	**Pattern Symbol**	**Number of Teams High Performing**	**Number of Teams Low Performing**
Constant increase between periods 1, 2 and 3.	/	2	1
Growth between period 1 to period 2, then a decrease to period 3.	∧	2	1
Constant decrease between periods 1, 2 and 3.	\	0	1
Decrease between period 1 to period 2 then a growth again to period 3	∨	0	1

Note: See Table 6.7 for definition of symbols.

Result Q1

There were no patterns that differentiate the use of <u>goal-oriented</u> decision-making between the high performing groups and the low performing groups across three-time



WEEK	H1	L1	H2	L2	H3	L3	H4	L4
P 1 and 2	47%	78%	80%	93%	67%	75%	81%	53%
P 3	53%	22%	20%	7%	33%	25%	19%	47%

Figure 6.7 – Activity-oriented Decisions for All Teams Across Time Periods

The activity-oriented decisions revealed three different patterns.

Pattern Description	Pattern Symbol	Number of Teams	
		High Performing	Low Performing
Growth between period 1 to period 2, then a decrease to period 3.	∧	2	2
Decrease between period 1 to period 2 then a growth again to period 3.	∨	2	1
Decrease between periods 1and 2 then remained constant to period 3.	L	0	1

Note: See Table 6.7 for definition of symbols.

Result Q2

There were no patterns that differentiate the use of <u>activity-oriented</u> decision-making between the high performing groups and the low performing groups across three-time period.

It was again expected that there were more goal-oriented and activity-oriented decisions in period 1 and period 2 combined than in period 3. Figure 6.6 and Figure 6.7 above show the percentage breakdown of both goal-oriented and activity-oriented decisions for periods 1 and 2 combined and period 3.

Four of the eight teams (2 high performing and 2 low performing) made more than 2/3 (66%) of the <u>goal-oriented</u> decisions during period 1 and period 2. The other 4 teams had less than 66% but only two teams (one high performing and one low performing) had more than 50% in period 3. The results for analyses 3 and 5 are:

Result Q3

Although half of the teams had more goal-oriented decisions made in first two periods combined than in the third period, two of the remaining teams had less than 50% of the decisions in the third period. This suggests that although these teams did not exceed the 66%, they made at least half of the goal-oriented decisions in the first two periods.

Result Q5

There was no difference between the high performing groups and the low performing groups in the timing of goal-oriented decisions made in the first two periods as opposed to the third period.

In activity-oriented decisions, 6 out of 8 teams made more than 2/3 (66%) of the decisions during period 1 and period 2. These were 3 high performing teams and 3 low performing teams. The other 2 teams had less than 66% but only one these teams (one high performing) had more than 50% in period 3. The results of analyses 4 and 6 are:

Result Q4

The majority of teams had more activity-oriented decisions made in first two periods combined than in the third period.

Result Q6

There was no difference between the high performing groups and the low performing groups in the timing of activity-oriented decisions made in the first two periods as opposed to the third period.

6.5.3. Challenged and Agreed Decisions Across Time Periods

Figure 6.8 and Figure 6.9 shows the challenged and agreed decisions across the three-time periods. It is important to note the differences in the maximum values of the scales between the two charts. Due to the lower number of challenges compared with the agreed number of decisions, the maximum value of the challenges was half (40) that of the agreed.

As in the previous analyses with implicit and explicit decisions and the goal-oriented and activity-oriented decisions, this analysis looked for patterns of use in the challenged and agreed decisions that differentiate between the high performing groups and the low performing groups. Analyses in the previous sections (6.5.1, 6.5.2) have shown that at least 66% of decisions were made within the first two periods. As this analysis looked at the challenges and agreements to those decisions, it was again assumed that the majority of decisions were made in the first two periods. This analysis therefore looked for the greater number of decisions made by all teams during the first two periods. This analysis also looked for differences between the high performing groups and the low performing groups in the use of challenges and agreements to decisions. As with the analysis in section 6.5.1 and section 6.5.2, there are six questions.

Questions

Q- **1** were there differences between the high performing groups and the low performing groups in the use of challenged decisions?

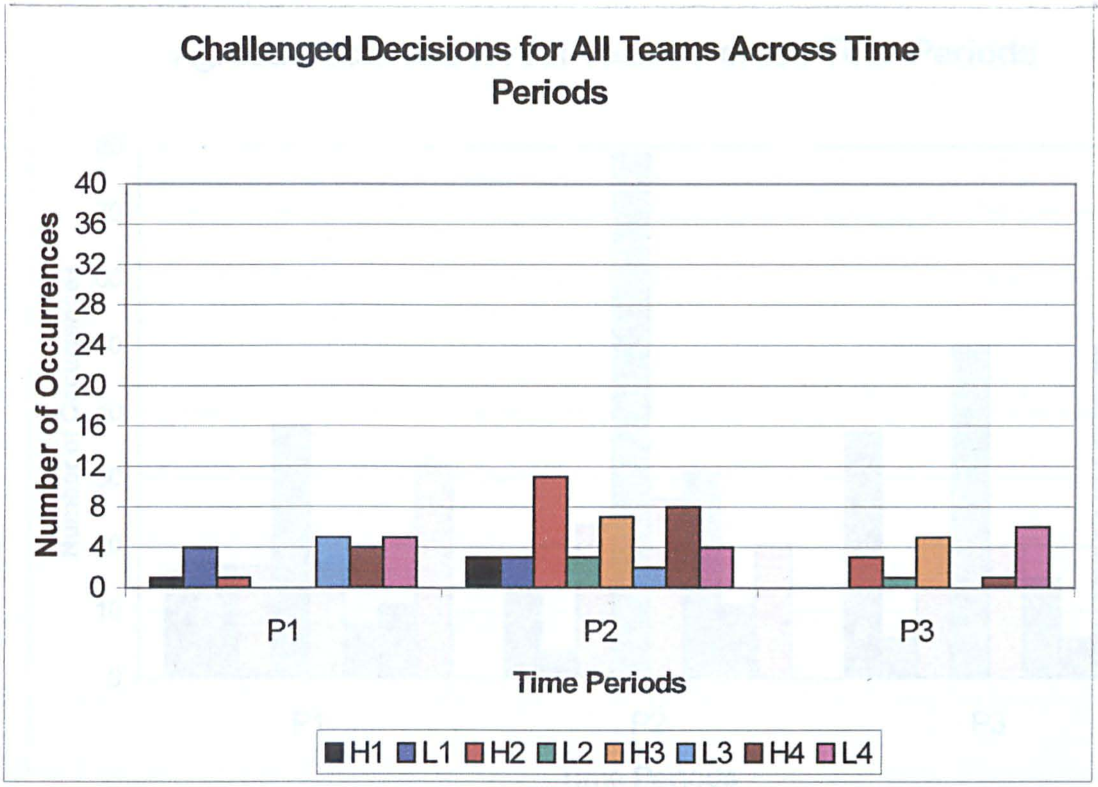
Q - **2** were there differences between the high performing groups and the low performing groups in the use of agreed decisions?

Q - **3** were there more challenged decisions made in first two periods combined than in the third period?

Q - **4** were there more agreed decisions made in first two periods combined than in the third period?

Q - **5** was there a difference between the high performing groups and the low performing groups in the timing of challenged decisions made in the first two periods as opposed to the third period?

Q - **6** was there a difference between the high performing groups and the low performing groups in the timing of agreed decisions made in the first two periods as opposed to the third period?



WEEK	H1	L1	H2	L2	H3	L3	H4	L4
P 1 and 2	100%	100%	80%	75%	58%	100%	92%	60%
P 3	0%	0%	20%	25%	42%	0%	8%	40%

Figure 6.8 - Challenged Decisions for All Teams Across Time Periods

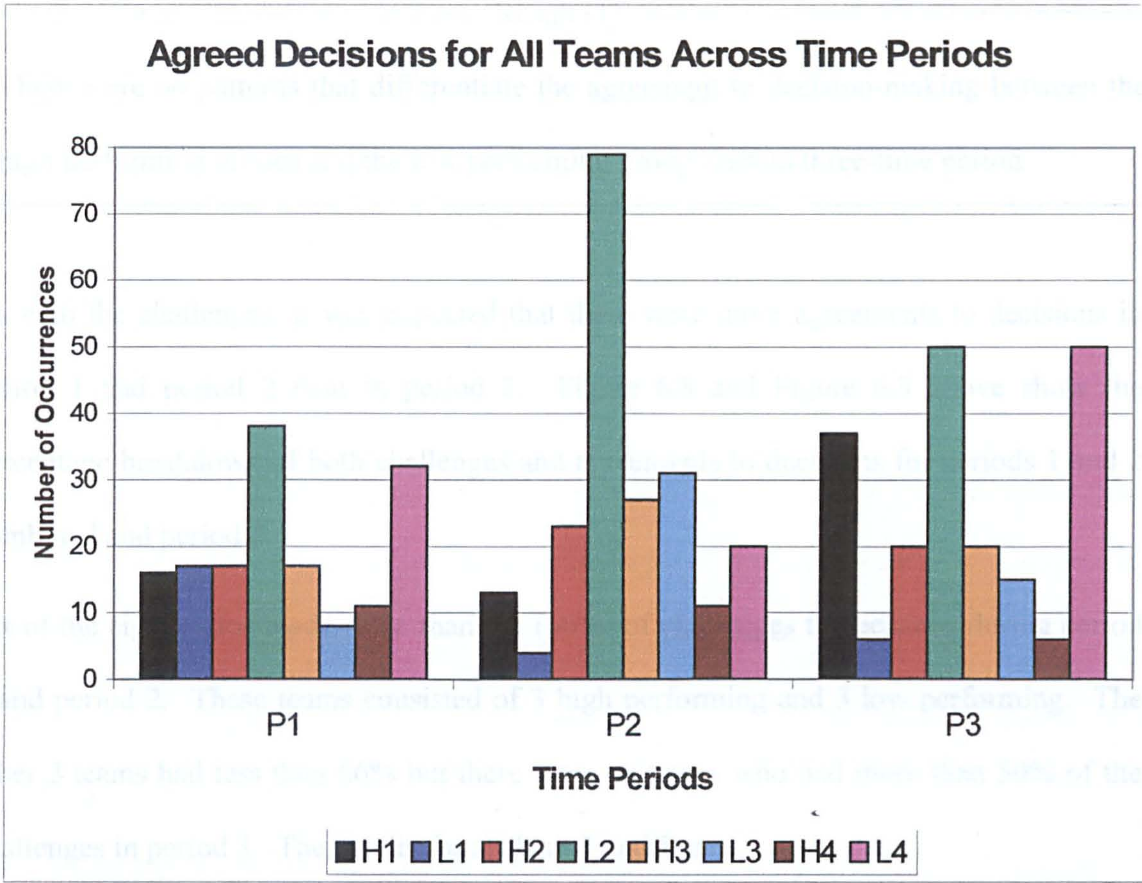
Three patterns emerged when analysing the challenges to decisions across three-time periods.

Pattern Description	Pattern Symbol	Number of Teams	
		High Performing	Low Performing
Growth between period 1 to period 2, then a decrease to period 3.	^	4	1
Constant decrease between periods 1, 2 and 3.	\	0	2
Decrease between period 1 to period 2 then a growth again to period 3	v	0	1

Note: See Table 6.7 for definition of symbols.

Result Q1

All the high performing teams had the same pattern of challenges whereas the low performing teams had different patterns of challenges across three-time period.



WEEK	H1	L1	H2	L2	H3	L3	H4	L4
P 1 and 2	44%	78%	67%	70%	69%	72%	79%	51%
P 3	56%	22%	33%	30%	31%	28%	21%	49%

Figure 6.9 - Agreed Decisions for All Teams Across Time Periods

The agreed decisions revealed three different patterns.

Pattern Description	Pattern Symbol	Number of Teams	
		High Performing	Low Performing
Growth between period 1 to period 2, then a decrease to period 3.	^	2	2
Decrease between period 1 to period 2 then a growth again to period 3.	v	1	2
Constant between periods 1and 2 then decrease to period 3.	¬	1	0

Note: See Table 6.7 for definition of symbols.

Result Q2

There were no patterns that differentiate the agreement to decision-making between the high performing groups and the low performing groups across three-time period.

As with the challenges, it was expected that there were more agreements to decisions in period 1 and period 2 than in period 3. Figure 6.8 and Figure 6.9 above show the percentage breakdown of both challenges and agreements to decisions for periods 1 and 2 combined and period 3.

Six of the eight teams made more than 2/3 (66%) of challenges to decisions during period 1 and period 2. These teams consisted of 3 high performing and 3 low performing. The other 2 teams had less than 66% but there were no teams who had more than 50% of the challenges in period 3. The results for analyses3 and 5 are:

Result Q3

The majority of teams had more challenges to decisions in the first two periods combined than in the third period.

Result Q5

There was no difference between the high performing groups and the low performing groups in the timing of challenges to decisions made in the first two periods as opposed to the third period.

Again, 6 out of 8 teams had more than 2/3 (66%) of agreements to decisions during period 1 and period 2. These were 3 high performing teams and 3 low performing teams. The other 2 teams had less than 66% but only one of these teams (one high performing) had more than 50% in period 3. The results of analyses 4 and 6 are:

Result Q4

The majority of teams had more agreed decisions made in first two periods combined than in the third period.

Result Q6

There was no difference between the high performing groups and the low performing groups in the timing of agreed decisions made in the first two periods as opposed to the third period.

6.6. Comparison of Decision Types Across All Teams

Analyses carried out in Chapter 5 showed that there were differences in the amount of communication between all teams. Further analyses carried out in section 6.4.2 also showed that the teams were very different in the total number of decisions they made. The following sections (6.6.1, 6.6.2, 6.6.3) will look for patterns across all teams for each of the decision types identified in section 6.3.

6.6.1. Comparison Of Implicit Vs Explicit Decisions For All Teams

Table 6.8 below, shows the total number of implicit and explicit decisions for each team as well as their appropriate percentages. All teams had more implicit decisions than explicit decisions.

Table 6.8 – Total Number of Explicit and Implicit Decisions

Explicit Vs. Implicit					
Team No.	**I**	**E**	**I Prcnt**	**E Prcnt**	**TOTAL**
High Performing					
H1	55	15	79%	21%	70
H2	55	20	73%	27%	75
H3	46	30	61%	39%	76
H4	23	18	56%	44%	41
Low Performing					
L1	22	12	65%	35%	34
L2	101	70	59%	41%	171
L3	41	20	67%	33%	61
L4	75	42	64%	36%	117
TOT – HIGH	179	83	68%	32%	262
TOT – LOW	239	144	62%	38%	383
TOT – ALL	418	227	65%	35%	645

A significance test was carried out to compare the total implicit and explicit decisions of all 8 teams. This analysis looked for statistically significant differences in the implicit and explicit decisions made by all 8 teams. The null hypothesis (*H0*) for this test is:

Null Hypothesis

Ho: there was no significant difference between the implicit and explicit decisions made between the 8 individual teams

This test looked at more than one variable, the implicit decisions and the explicit decisions and used the standard Chi-Square Test (χ^2) explained in Chapter 5.

Table 6.9 below shows the test results.

- Column 2 - observed frequencies (O) for Implicit Decisions.
- Column 3 - observed frequencies (O) for Explicit Decisions.

- Column 4 - observed frequencies (O) for the total number of decisions (Implicit and Explicit).
- Column 5 - calculated expected frequencies (E) for Implicit Decisions.
- Column 6 - calculated expected frequencies (E) for Explicit Decisions.

Table 6.9 - Comparison of Implicit and Explicit Decisions for all 8 Teams

						Chi-Sq Test	
Team No.	**Imp (OB)**	**Exp (OB)**	**Total (OB)**	**Imp (EX)**	**Exp (EX)**	**Chi-Imp**	**Chi-Exp**
H1	55	15	70	45.4	24.6	2.0	3.8
L1	22	12	34	22.0	12.0	0.0	0.0
H2	55	20	75	48.6	26.4	0.8	1.5
L2	101	70	171	110.8	60.2	0.9	1.6
H3	46	30	76	49.3	26.7	0.2	0.4
L3	41	20	61	39.5	21.5	0.1	0.1
H4	23	18	41	26.6	14.4	0.5	0.9
L4	75	42	117	75.8	41.2	0.0	0.0
Total	418	227	645	418.0	227.0	4.5	8.3
						Chi-SQ Total - 12.8	

The Chi-Square Test (χ^2) result was 12.8 with 7 *degrees of freedom.*

Result

The result was **not significant** with p>0.05. The null hypothesis (*H0*) in this test was supported. The result shows that there was no difference between the implicit and explicit decisions made by the 8 individual teams.

6.6.2. Comparison Of Goal Vs. Activity Oriented Decisions For All Teams

Table 6.10 below, shows the total number of goal-oriented and activity-oriented decisions for each team as well as their appropriate percentages. All teams except for team L2, had more activity-oriented decisions than goal-oriented decisions.

Table 6.10 – Total Number of Goal-oriented and Activity oriented Decisions

Goal Vs. Activity					
Team No.	**G**	**A**	**G Prcnt**	**A Prcnt**	**TOTAL**
High Performing					
H1	27	43	39%	61%	70
H2	29	46	39%	61%	75
H3	37	39	49%	51%	76
H4	5	36	12%	88%	41
Low Performing					
L1	11	23	32%	68%	34
L2	87	84	51%	49%	171
L3	17	44	28%	72%	61
L4	49	68	42%	58%	117
TOT HIGH	**98**	**164**	**37%**	**63%**	**262**
TOT LOW	**164**	**219**	**43%**	**57%**	**383**
TOT ALL	**262**	**383**	**41%**	**59%**	**645**

As in the previous section, a significance test was carried out to compare the total number of goal-oriented and activity-oriented decisions of all 8 teams. This analysis looked for statistically significant differences in the goal-oriented and activity-oriented decisions made by all 8 teams. The null hypothesis (*H0*) for this test is:

Null Hypothesis

Ho: there was no significant difference between the goal-oriented and activity-oriented decisions made between the 8 individual teams.

This test looked at more than one variable, the goal-oriented and activity-oriented decisions and used the standard Chi-Square Test (χ^2). Table 6.11 below shows the test results.

- Column 2 - observed frequencies (O) for goal-oriented decisions.
- Column 3 - observed frequencies (O) for activity-oriented decisions.
- Column 4 - observed frequencies (O) for the total number of decisions (goal-oriented and activity-oriented).
- Column 5 - calculated expected frequencies (E) for goal-oriented decisions.
- Column 6 - calculated expected frequencies (E) for activity-oriented decisions.

Table 6.11 - Comparison of Goal and Activity Decisions

						Chi-Sq Test	
Team No.	**Goal (OB)**	**Act (OB)**	**Total (OB)**	**Goal (EX)**	**Act (EX)**	**Chi-Goal**	**Chi-Act**
H1	27	43	70	28.4	41.6	0.1	0.0
L1	11	23	34	13.8	20.2	0.6	0.4
H2	29	46	75	30.5	44.5	0.1	0.0
L2	87	84	171	69.5	101.5	4.4	3.0
H3	37	39	76	30.9	45.1	1.2	0.8
L3	17	44	61	24.8	36.2	2.4	1.7
H4	5	36	41	16.7	24.3	8.2	5.6
L4	49	68	117	47.5	69.5	0.0	0.0
Total	**262**	**383**	**645**	**262.0**	**383.0**	**17.0**	**11.6**
						Chi-SQ Total – 28.6	

The Chi-Square Test (χ^2) result was 28.6 with 7 *degrees of freedom.*

Result

The result was **highly significant** with $p<0.001$. The null hypothesis (*H0*) in this test was not supported. The result shows that there was a difference between the goal-oriented and activity-oriented decisions made between the 8 individual teams.

6.6.3. Comparison Of Challenged Vs. Agreed Decisions For All Teams

Table 6.12 below, shows the total number of challenged and agreed decisions for each team as well as their appropriate percentages. All teams had more agreed decisions than challenged decisions.

Table 6.12 – Total Number of Challenged and Agreed Decisions for All Teams

Challenged Vs. Agreed					
Team No.	**C**	**Ag**	**C Prcnt**	**Ag Prcnt**	**TOTAL**
High Performing					
H1	4	66	6%	94%	70
H2	15	60	20%	80%	75
H3	12	64	16%	84%	76
H4	13	28	32%	68%	41
Low Performing					
L1	7	27	21%	79%	34
L2	4	167	2%	98%	171
L3	7	54	11%	89%	61
L4	15	102	13%	87%	117
TOT HIGH	**44**	**218**	**17%**	**83%**	**262**
TOT LOW	**33**	**350**	**9%**	**91%**	**383**
TOT ALL	**77**	**568**	**12%**	**88%**	**645**

A significance test was carried out to compare the total number of challenges and agreements for all 8 teams. This analysis looked for statistically significant differences in the challenged and agreed decisions made by all 8 teams. The null hypothesis (*H0*) for this test is:

Null Hypothesis

Ho: there was no significant difference between the challenged and agreed decisions made between the 8 individual teams.

This test looked at more than one variable, the challenged and agreed decisions and used the standard Chi-Square Test (χ^2).

Table 6.13 below shows the test results.

- Column 2 - observed frequencies (O) for challenged decisions.
- Column 3 - observed frequencies (O) for agreed decisions.
- Column 4 - observed frequencies (O) for the total number of decisions (challenged and agreed).
- Column 5 - calculated expected frequencies (E) for challenged decisions.
- Column 6 - calculated expected frequencies (E) for agreed decisions.

Table 6.13 - Comparison of Challenged and Agreed Decisions for All Teams

						Chi-Sq Test	
Team No.	**Chal (OB)**	**Agr (OB)**	**Total (OB)**	**Chal (EX)**	**Agr (EX)**	**Chi-Chal**	**Chi-Agr**
H1	4	66	70	8.4	61.6	2.3	0.3
L1	7	27	34	4.1	29.9	2.1	0.3
H2	15	60	75	9.0	66.0	4.1	0.6
L2	4	167	171	20.4	150.6	13.2	1.8
H3	12	64	76	9.1	66.9	0.9	0.1
L3	7	54	61	7.3	53.7	0.0	0.0
H4	13	28	41	4.9	36.1	13.4	1.8
L4	15	102	117	14.0	103.0	0.1	0.0
Total	**77**	**568**	**645**	**77.0**	**568.0**	**36.1**	**4.9**
						Chi-SQ Total- 41.0	

The Chi-Square Test (χ^2) result was 41.0 with 7 *degrees of freedom.*

Result

The result was **highly significant** with $p<0.001$. The null hypothesis (*H0*) in this test was not supported. The result shows that there was a difference between the challenged and agreed decisions made between the 8 individual teams.

6.7. Comparison of Decision Types Across the High Performing Groups and the Low Performing Groups

Analyses on communication (Chapter 5) showed differences between the total amount of communication in the combined high performing teams and the total amount of communication in the combined low performing teams. Analyses on decisions in section 6.4.3 also showed differences in the amount of decisions between the high performing groups and the low performing groups. Sections 6.7.1, 6.7.2, 6.7.3 looked for differences between the high performing groups and the low performing groups in the total number of each decision type.

6.7.1. Comparison Of Implicit Vs. Explicit Decisions for the High Performing Groups and the Low Performing Groups

This analysis looked for statistically significant differences in the total number of implicit and explicit decisions for the high performing groups and the low performing groups:

Null Hypothesis

Ho: there was no significant difference between the implicit and explicit decisions made by the high performing groups and the low performing groups.

This test looked at more than one variable, the implicit and explicit decisions and used the standard Chi-Square Test (χ^2).

Table 6.14 below shows the test results.

- Column 2 - observed frequencies (O) for implicit decisions.
- Column 3 - observed frequencies (O) for explicit decisions.
- Column 4 - observed frequencies (O) for the total number of decisions (implicit and explicit).
- Column 5 - calculated expected frequencies (E) for implicit decisions.

- Column 4 - observed frequencies (O) for the total number of decisions (implicit and explicit).
- Column 5 - calculated expected frequencies (E) for implicit decisions.
- Column 6 - calculated expected frequencies (E) for explicit decisions.

Table 6.14 - Comparison of Implicit and Explicit for Total Performance

						Chi-Sq Test	
Team Performance	**Imp (OB)**	**Exp (OB)**	**Total (OB)**	**Imp (EX)**	**Exp (EX)**	**Chi-Imp**	**Chi-Exp**
High Total	179	83	262	169.8	92.2	0.50	0.92
Low Total	239	144	383	248.2	134.8	0.34	0.63
Total	418	227	645	418.0	227.0	0.84	1.55
						Chi-SQ Total – 2.39	

The Chi-Square Test (χ^2) result was 2.39 with 1 *degree of freedom.*

Result

The result was **not significant** with p>0.05. The null hypothesis (*H0*) in this test was supported. The result does not show a difference between the implicit and explicit decisions made between the high performing groups and the low performing groups.

6.7.2. Comparison Of Goal-Oriented Vs. Activity-Oriented Decisions for the High Performing Groups and the Low Performing Groups

This analysis looked for statistically significant differences in the goal-oriented and activity-oriented decisions made by the high performing groups and the low performing groups. The null hypothesis (*H0*) for this test is:

Null Hypothesis

Ho: there was no significant difference between the goal-oriented and activity-oriented decisions made by the high performing groups and the low performing groups.

This test looked at more than one variable, the goal-oriented and activity-oriented decisions and used the standard Chi-Square Test (χ^2).

Table 6.15 below shows the test results.

- Column 2 - observed frequencies (O) for goal-oriented decisions.
- Column 3 - observed frequencies (O) for activity-oriented decisions.
- Column 4 - observed frequencies (O) for the total number of decisions (goal-oriented and activity-oriented).
- Column 5 - calculated expected frequencies (E) for goal-oriented decisions.
- Column 6 - calculated expected frequencies (E) for activity-oriented decisions.

Table 6.15 - Comparison of Goal and Activity Oriented Decisions for Total Performance

						Chi-Sq Test	
Team Performance	**Goal (OB)**	**Act (OB)**	**Total (OB)**	**Goal (EX)**	**Act (EX)**	**Chi-Goal**	**Chi-Act**
High Total	98	164	262	106.4	155.6	0.67	0.46
Low Total	164	219	383	155.6	227.4	0.46	0.31
Total	**262**	**383**	**645**	**262.0**	**383.0**	**1.12**	**0.77**
						Chi-SQ Total – 1.89	

The Chi-Square Test (χ^2) result was 1.89 with 1 *degree of freedom.*

Result

The result was **not significant** with p>0.05. The null hypothesis (*H0*) in this test was supported. The result does not show a difference between the goal-oriented and activity-oriented decisions made between the high performing groups and the low performing groups.

6.7.3. Comparison Of Challenged Vs. Agreed Decisions for the High Performing Groups and the Low Performing Groups

This analysis looked for statistically significant differences in the challenged and agreed decisions made by the high performing groups and the low performing groups. The null hypothesis (*H0*) for this test is:

Null Hypothesis

Ho: there was no significant difference between the challenged and agreed decisions made by the high performing groups and the low performing groups.

This test looked at more than one variable, the challenged and agreed decisions and used the standard Chi-Square Test (χ^2).

Table 6.16 below shows the test results.

- Column 2 - observed frequencies (O) for challenged decisions.
- Column 3 - observed frequencies (O) for agreed decisions.
- Column 4 - observed frequencies (O) for the total number of decisions (challenged and agreed).
- Column 5 - calculated expected frequencies (E) for challenged decisions.
- Column 6 - calculated expected frequencies (E) for agreed decisions.

Table 6.16 - Comparison of Challenge and Agreed for Total Performance

						Chi-Sq Test	
Team Performance	**Chal (OB)**	**Agr (OB)**	**Total (OB)**	**Chal (EX)**	**Agr (EX)**	**Chi-Chal**	**Chi-Agr**
High Total	44	218	262	31.3	230.7	5.18	0.70
Low Total	33	350	383	45.7	337.3	3.54	0.48
Total	**77**	**568**	**645**	**77.0**	**568.0**	**8.72**	**1.18**
						Chi-SQ Total – 9.90	

The Chi-Square Test (χ^2) result was 9.90 with 7 *degrees of freedom*

Result

The result was **significant** with p<0.05. The null hypothesis (*H0*) in this test was not supported. The result shows that there was a difference between the challenged and agreed decisions made between by the high performing groups and the low performing

6.8. Decision Strategy Methods Used

In order to make a decision choice the groups usually adopt a decision-making strategy. Hartley (1997) suggests seven different decision methods (reflected in Table 6.1), which a group can adopt. The teams studied in this project did not consciously choose a particular decision method but rather adopted several methods according to the team's role structure or individual circumstances.

Table 6.17 below outlines the percentage use of each decision method for each team.

Columns 2-8 (row 1) shows the labels given to each method, M1-M7, described (row 2) as per Hartley (1997).

Rows 4-11 give each team's percentage of the use of each method throughout the total project timeline.

Column 9 shows the total number of methods used by each team.

Row 12 gives the total number of teams, along with the breakdown of high and low teams that used each particular method.

Table 6.17 - Percentage of Decision Methods (Methods adapted from Hartley, 1997)

Percentage of Decision Method Used by Each Team								
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	
	Decision by authority without discussion	Decision by authority after discussion	Decision by expert member	Average members' opinions	Majority control.	Minority control	Con-sensus	**Tot Mthd**
H1	0%	0%	34%	14%	3%	23%	26%	5
L1	0%	0%	44%	0%	0%	41%	15%	3
H2	0%	0%	25%	12%	3%	28%	32%	5
L2	23%	0%	30%	7%	12%	5%	23%	6
H3	3%	4%	45%	18%	7%	5%	18%	7
L3	2%	2%	41%	0%	3%	23%	30%	6
H4	7%	0%	34%	0%	0%	15%	44%	4
L4	2%	0%	32%	23%	6%	32%	5%	6
Tot	5(2h/3l)	2(1h/1l)	8(4h/4l)	5(3h/2l)	6(3h/3l)	8(4h/4l)	8(4h/4l)	

6.8.1. Assigning Methods

As stated earlier in this chapter, this research not only looked at specific decision types but also at the way decisions were made. This therefore looked at the person or persons who proposed a decision and their role in the group. It also considered whether or not the decision was challenged, and if so by how many group members or if agreed again by how many in the group. In order to assign a particular method to a decision, for this analysis, specific guidelines for each decision method were followed.

For method 1 (M1), *decision by authority without discussion* to be assigned, the person in authority would have made a decision - in this case the team leader without any discussion.

Method 2 (M2), *decision by authority after discussion* would be assigned if the team leader again made the decision but a discussion on the subject had occurred either before or after the decision was made.

Method 3 (M3), *decision by expert member* was used when the *expert* or the person assigned to the job in the area surrounding that decision made the decision.

An *average member's* opinions as stated in method 4 (M4) was recognised when the decision was made by a person who was not seen as the expert or the authority figure but was rather an average member of the group.

Method 5 (M5) *majority control* and 6 (M6) *minority control* were assigned when a decision was made and agreed by the majority (M5) members of the group (half or more but not all), or the minority (M6) members of the group (less than half).

Method 7 (M7) *consensus* was recognised when a decision was made and agreed to by all the members of the group.

6.8.2. Spread of Methods Used by the High Performing Groups and the Low Performing Groups

All teams used more than 1 method. The high performing teams used between 4-7 methods with 5 methods being the mode. The low performing teams used 3-6 methods with 6 methods being the mode. The most used methods used by all teams were M3 *decision by expert member*, M6 *minority control* and M7 *consensus*. The least used method was M2 *decision by authority after discussion.*

Table 6.18 illustrates the breakdown use of each method by the high performing groups and low performing groups. There were no methods exclusively used by the high performing groups or the low performing groups. This analysis used the standard deviation measure to look at the spread or distribution of the number of methods used by each of the low performing teams and each of the high performing teams. Previous analyses have shown that the high performing groups and the low performing groups had different amounts of communication and different amounts of decisions. This analysis assumed that the high performing groups and the low performing groups also differed in the number of strategy methods used for decision-making. The formula used in calculating the standard deviation was as previously identified in Chapter 5.

Null Hypothesis

Ho: there were no differences in the spread of total number of methods between the high performing groups and the low performing groups.

Table 6.18 - Distribution of Decision Strategy Methods

Team No.	Total Methods	Mean (average)	Deviation (d)	Squared Deviation (d^2)
High Performing Teams				
H1	5	5.25	-0.25	0.063
H2	5	5.25	-0.25	0.063
H3	7	5.25	1.75	3.063
H4	4	5.25	-1.25	1.563
Total High	**21**	$S = \sqrt{4.752/4-1} = 1.259$		
Low Performing Teams				
L1	3	5.25	-2.25	5.063
L2	6	5.25	0.75	0.563
L3	6	5.25	0.75	0.563
L4	6	5.25	0.75	0.563
Total Low	**21**	$S = \sqrt{6.752/4-1} = 1.500$		

Results showed the spread or variance in the high performing groups at 1.259 and in the low performing groups at 1.500.

Result

The null hypothesis (*Ho*) in this test was not supported. There was a minor difference in the spread of totals within the high performing teams and the spread of totals within the low performing teams.

6.8.3. Team Pattern Distribution of Methods Across Three-Time Periods

Table 6.19 below shows the decision-strategy method patterns for all teams across three-time periods. The pattern symbols follow the same guidelines as per previously identified patterns. The patterns look at the growth, decline or steadiness between periods 1, 2 and 3.

Column 9 shows the total number of patterns used by each team.

Row 2 shows the labels given to each method, M1-M7 as per Hartley (1997)

Row 11 shows the total number of patterns used in each method.

The range of total number of patterns used by the low performing teams was 3-4.

The range of total number of patterns used by the high performing teams was 3-5.

Table 6.19 - Decision Strategy Method Patterns for all Teams

Decision-Strategy Method Patterns for All Teams								
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**Total Patterns**
H1	—	—	/	∨	¬	∨	∧	5
L1	—	—	└	—	—	\	\	3
H2	—	—	∧	∧	┌	\	∧	4
L2	∧	—	∧	∧	∧	¬	/	4
H3	\	∨	/	∧	∧	┘	\	5
L3	∧	∧	∧	—	∧	∧	\	3
H4	—	—	∧	—	—	\	∧	3
L4	/	—	/	∨	∧	∨	∧	4
No. of patterns	4	3	3	3	4	5	3	
Pattern break-down	**—4** *(3h/1l)*	**—6** *(3h/3l)*	**∧4** *(2h/2l)*	**—3** *(1h/2l)*	**∧4** *(1h/3l)*	**\3** *(2h/1l)*	**∧4** *(3h/1l)*	
	∧2 *(2l)*	**∧1** *(1l)*	**/3** *(2h/1l)*	**∧3** *(2h/1l)*	**—2** *(1h/1l)*	**∨2** *(1h/1l)*	**\3** *(1h/2l)*	
	\1 *(1h)* **/1** *(1l)*	**∨1** *(1h)*	**└1** *(1l)*	**∨2-** *(1h/1)l*	**¬1** *(1h)*	**∧1** *(1l)*	**/1** *(1l)*	
					┌1 *(1h)*	**¬1** *(1l)* **┘1** *(1h)*		

Note: See Table 6.7 for definition of symbols.

- The most used pattern, with 19 total occurrences was symbolised as ∧ and saw a growth in use between periods 1 and 2 then a decrease onto period 3.
- The next used pattern with 15 occurrences was symbolised as — and shows a steady state (no increase or decrease) between periods 1, 2 and 3. This pattern however also included the lack of use of any method, which was represented by a steady number of 0 between periods 1, 2 and 3. Of the 15 occurrences noted in the — pattern, 14 of those showed no use (or 0) in the particular method. The only occurrence that showed a steadiness of one use between periods 1, 2 and 3 was team H4's use of method 1.
- In total 56 patterns were observed (7 methods X 8 teams) but only 8 had a movement (increase or decrease) of 10 or more occurrences between time periods. Three of these movements were in team L4 alone.
- The number of patterns for the three most popular methods (M3, M6 and M7) ranges between 3-5.
- The most common pattern in each of methods 3 and 7 was symbolised as ∧ and shows an increase in use from period 1 to period 2 then a decrease onto period 3.
- The most common pattern for method 6, symbolised as \, was a decrease from period 1 to 2 to period 3.
- The least used method, M2, had only two different and contradicting patterns (∨ and ∧).
- Row 12 shows the breakdown of the total patterns (identified in row 11) with the number of high performing groups and low performing groups (*in italics*) that use each pattern.

The breakdown of uses of individual patterns by the low performing teams and the high performing teams was even in only some methods and some patterns. Further investigation (shown in section 6.8.4) was conducted on the decision-making method patterns of the combined high performing groups and the combined low performing.

6.8.4. High Group Performance and Low Group Performance Pattern Distribution Across Three Time Periods

Table 6.20 below shows the totals for the high performing groups and the totals for the low performing groups' use of methods across the three-time periods. Row 1 shows the labels given to each method, M1-M7 as per Hartley (1997). The values in rows 3, 4, 5 (high performing groups) and 9, 10, 11 (low performing groups) are illustrated in ***Figure 6.10*** and ***Figure 6.11***.

Table 6.20 - High Performing Groups and Low Performing Groups' Methods across Time

PERIOD	M1	M2	M3	M4	M5	M6	M7
High Performing Groups							
P1	3	2	5	7	3	20	27
P2	1	0	35	16	5	13	33
P3	1	1	51	10	1	14	14
Pattern	\	∨	/	∧	∧	∨	∧
Totals	**5**	**3**	**91**	**33**	**9**	**47**	**74**
Low Performing Groups							
P1	13	0	23	19	6	26	22
P2	15	1	64	10	17	18	21
P3	14	0	43	10	7	29	25
Pattern	∧	∧	∧	L	∧	∨	∨
Totals	42	1	130	39	30	73	68
Difference between High Tot and Low Tot	37	2	39	6	21	26	6

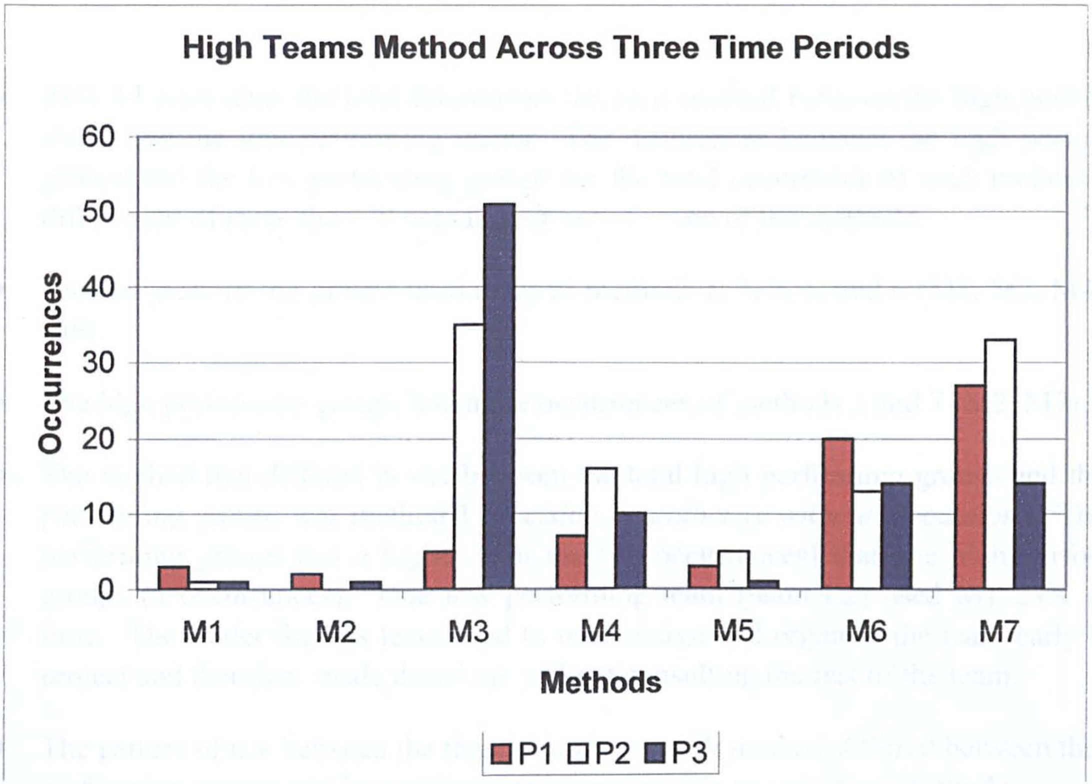


Figure 6.10 - High Performing Groups' Methods across Time

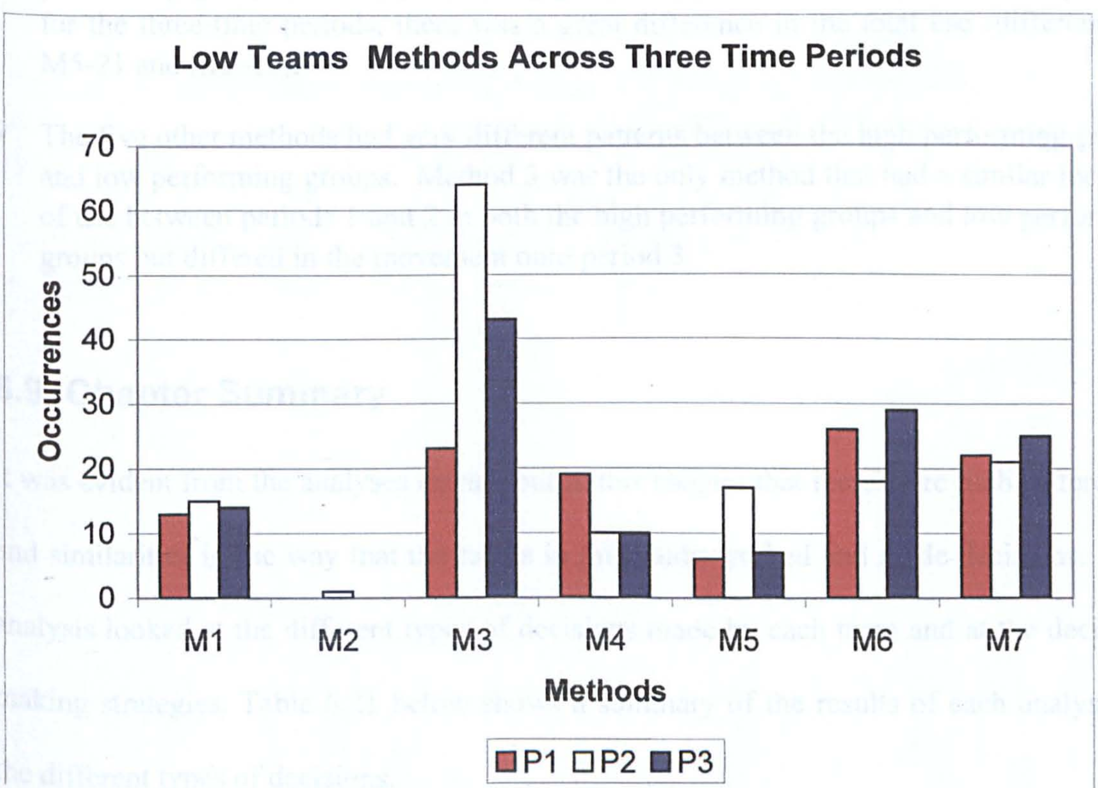


Figure 6.11 - Low Teams' Methods Across Time Period

- Row 14 represents the total differences for each method between the high performing teams and the low performing teams. The differences between the high performing groups and the low performing groups for the total occurrence of each method show differences of more than 20 uses in four out of seven of the methods.
- The low performing groups used more of methods 1, 3, 4, 5, and 6 (M1, M3, M4, M5, M6).
- The high performing groups had more occurrences of methods 2 and 7 (M2, M7).
- The method that differed in use between the total high performing groups and the low performing groups was method 1 (*decision by authority without discussion*). The low performing groups had a higher total use (42 occurrences) than the high performing groups (5 occurrences). One low performing team (team L2) used M1 23% of the time. The leader for this team tried to take charge and organise the team early in the project and therefore made decisions without consulting the rest of the team.
- The pattern of use between the three periods for each method differed between the high performing groups and low performing groups in five out of seven methods.
- The two methods that had similar patterns in the high performing groups and low performing groups, were methods 5 and 6 (M5-∧, M6-∨). Although the high performing groups and low performing groups' methods 5 and 6 had the same patterns for the three-time periods, there was a great difference in the total use (difference of M5-21 and M6–26).
- The five other methods had very different patterns between the high performing groups and low performing groups. Method 3 was the only method that had a similar increase of use between periods 1 and 2 in both the high performing groups and low performing groups but differed in the movement onto period 3.

6.9. Chapter Summary

It was evident from the analyses carried out in this chapter that there were both differences and similarities in the way that the teams in this study worked and made decisions. This analysis looked at the different types of decisions made by each team and at the decision-making strategies. Table 6.21 below shows a summary of the results of each analysis on the different types of decisions.

Column 1 shows the various types of decisions made, starting with a look at the total decisions in row 1.

Columns 2-4 show the results of analyses carried out for each decision type across three-time periods.

Column 2 shows the number of different patterns tracked along the three-time periods.

Column 3 describes the most common (MC-used by more than 4 teams) or most used (MU-used by 4 or less teams) pattern and gives the number of high (H) and low (L) teams that followed that pattern.

Columns 4 and 5 give the dispersal pattern of the high performing teams (column 4) and the low performing teams (column 5) across the different patterns observed. The numbers given in each column represent the number of teams, in descending order that followed each of the patterns stated in column 2.

Columns 6 and 7 give a breakdown of the number of high performing teams (column 6) and low performing teams (column 7) that had more than 2/3 (66%) of their decisions in periods 1 and 2 combined.

Columns 8 and 9 give a breakdown of the number of high performing teams (column 8) and low performing teams (column 9) that had more than 50% of their decisions in period 3.

Columns 10 and 11 show the maximum <u>expected</u> (column 10-E) and the maximum <u>actual</u> (column 11-A) decision type occurrence in periods 1 and period 2.

Columns 12 and 13 summarise the chi-square test results in the comparison of decision types for all teams (column 12) and for high performing teams and low performing teams (column 13).

Columns 14 and 15 show the breakdown in percentages of the usage of each decision type by high performing teams (column 14) and low performing teams (column 15).

Table 6.21 - Summary of Analyses

Summary of Analyses														
Dec Type	**# of pttrns**	**MC or MU pttrn**	**Pattern Dispersal**		**> 2/3 in P1 and P2**		**> 50% in P3**		**Max dec type in P1 andP2**		**χ^2 result all teams**	**χ^2 result H/ L teams**	**% of use**	
			H	**L**	**H**	**L**	**H**	**L**	**E**	**A**			**H**	**L**
Tot Dec	3	^-3h/21	3,1,0	2,1,1	3	3	1	0			Signi High	Signi High		
Impl	4	^-2h/21	2,0,1,1	2,2,0,0	2	3	1	0	Exp	Exp 2h/21	Signi None	Signi None	68	62
Expl	3	^-3h/21	3,1,0	2,1,1	2	3	1	1					32	38
Goal	4	^-2h/11 /-2h/11	2,2,0,0	1,1,1,1	2	2	1	1	Goal	Goal 3h/21	Signi High	Signi None	37	43
Acti	3	^-2h/21	2,2,0	2,1,1	3	3	1	0					63	57
Chal	3	^-4h/11	4,0,0	1,2,1	3	3	0	0	Chal	Chal 3h/41	Signi High	Signi	17	9
Agrd	3	^-2h/21	2,1,1	2,2,0	3	3	1	0					83	91

Note: See Table 6.7 for definition of symbols.

A summary of the results reflected in Table 6.21 above can be broken down into the following 5 sections.

6.9.1. Summary of Total Number of Decisions

Analyses on the total number of decisions found:

- The majority of teams made more than 2/3 (66%) of the total decisions within the first two periods.
- Differences in the spread of total number of decisions between the high performing groups and the low performing groups.

- The eight teams studied were very different in their total number of decisions.
- The high performing teams tend to make fewer decisions than the low performing teams.
- There was no relationship between the team average mark (TAM) ranking and the ranking of total number of decisions.
- There was no relationship between the total communication ranking and the ranking of total number of decisions.

The test results for the total number of decisions, as stated above, were consistent with similar significance tests previously carried out on the total communication (Chapter 5). The results show that one possible reason for the difference among the eight teams was that the high performing teams tended to make fewer communications and fewer decisions than the low performance teams. The high performing teams and low performing teams studied were very different in their total number of decisions.

6.9.2. Summary of Decision Types across Time Periods

Analyses on the decision types across the three-time period found:

Explicit and Implicit Decisions Across Time Periods

- No difference in the use of implicit decision-making between the high performing groups and the low performing groups across the three-time period.
- No differences in the use of explicit decision-making between the high performing groups and the low performing groups across the three-time period.
- The majority of teams had more implicit decisions made in first two periods combined than in the third period.
- No difference between the high performing groups and the low performing groups in the timing of implicit decisions made in the first two periods as opposed to the third period.
- The majority of teams had more explicit decisions made in first two periods combined than in the third period.

- No difference between the high performing groups and the low performing groups in the timing of explicit decisions made in the first two periods as opposed to the third period.

Goal and Activity Oriented Decisions Across Time Periods

- No difference in the use of goal-oriented decision-making between the high performing groups and the low performing groups across the three-time period.
- No difference in the use of activity-oriented decision-making between the high performing groups and the low performing groups across the three-time period.
- Half of the teams had more goal-oriented decisions made in first two periods combined than in the third period.
- No difference between the high performing groups and the low performing groups in the timing of goal-oriented decisions made in the first two periods as opposed to the third period.
- The majority of teams had more activity-oriented decisions made in first two periods combined than in the third period.
- No difference between the high performing groups and the low performing groups in the timing of activity-oriented decisions made in the first two periods as opposed to the third period.

Challenged and Agreed Decisions Across Time Periods

- All the high performing teams had the same pattern of challenges whereas the low performing teams had different patterns of challenges across the three-time period.
- No difference in the agreement to decision-making between the high performing groups and the low performing groups across the three-time period.
- The majority of teams had more challenges to decisions in the first two periods combined than in the third period.
- No difference between the high performing groups and the low performing groups in the timing of challenges to decisions made in the first two periods as opposed to the third period.
- The majority of teams had more agreed decisions made in first two periods combined than in the third period.

- No difference between the high performing groups and the low performing groups in the timing of agreed decisions made in the first two periods as opposed to the third period.

In making implicit and explicit decisions and goal-oriented, activity-oriented decisions and agreement to decisions, all teams had similar patterns of use across time. There were differences between the high performing groups and the low performing groups in decisions challenged across time. The high performing groups challenged decisions more than the low performing groups. In every decision type all teams had more decisions in the first two periods than the third period. This is consistent with the expectations from the software development lifecycle.

6.9.3. Summary of Comparison of Decision Types for all Teams

Analyses on the decision types for all 8 teams found:

- No significant difference between the number of implicit and explicit decisions made by the 8 individual teams.
- A significant difference between the number of goal-oriented and activity-oriented decisions made between the 8 individual teams.
- A significant difference between the number of challenged and agreed decisions made between the 8 individual teams.

The difference in the number of activity-oriented decisions and goal-oriented decisions helps to identify the teams' work process. Chapter 7 looks at the software development process along with the goal and activity oriented decision in more detail.

All teams had more implicit than explicit decisions. With the exception of one low performing team (team L2), all the teams had more activity-oriented decisions than goal-oriented decisions. All teams had more agreements to decisions than challenges.

6.9.4. Summary of Comparison of Decision Types for the High Performing Groups and the Low Performing Groups

Analyses on the decision types for the totals of the high performing groups and the total for the low performing groups found:

- No difference between the implicit and explicit decisions made between the high performing groups and the low performing groups.
- No difference between the goal-oriented and activity-oriented decisions made between the high performing groups and the low performing groups.
- A difference between the challenged and agreed decisions made between by the high performing groups and the low performing groups.

The only differences between the high performing groups and the low performing groups in the type of decisions made was in the challenges to decisions. The dispersal pattern (see also Table 6.21 above columns 4 and 5) for the high performing teams mainly clusters around 1 and 2 patterns whereas the low performing teams were more spread throughout the observed patterns. This shows that the high performing teams were more consistent in their decision-making patterns than the low performing teams. Challenging a decision generated communication and more knowledge about the issue being decided on. The fact that the high performing teams had more challenges than the low performing team implies that the high performing groups had more discussions about decisions than the low performing teams.

6.9.5. Summary of Methods Used

Analyses on the methods used for decision-making found:

- The spread of total methods used within the high performing teams was similar to the spread of totals for the low performing teams.

- The most used pattern of methods across the three-time periods was symbolised as ∧ (with 19 total occurrences) and saw a growth in use between periods 1 and 2 then a decrease onto period 3.

- The breakdown of uses of individual patterns by the low performing groups and the high performing groups was equal in only some methods and some patterns.

- The differences between the high performing groups and the low performing groups for the total occurrence of each method showed differences of more than 20 uses in four out of seven of the methods.

- The method that differed in use between the total high performing groups and the low performing groups was method 1 (*decision by authority without discussion*). The low performing groups had a higher total use (42 occurrences) than the high performing groups (5 occurrences).

- The pattern of use between the three periods for each method differed between the high performing groups and low performing groups in five out of seven methods.

There was no exclusively used method by any team. Each team took into account factors such as group make-up, individual roles, culture (Quaddus and Tung, 2002) and rising circumstances used a particular decision-strategy method. Evidence within the group communication showed that each team used a decision-strategy method suitable to the particular issue at hand rather than consciously choosing a particular method.

Table 6.22 below shows the patterns observed for each team in each decision type across the three-time period. The most common pattern ∧ was evident in more high performing teams (18 instances) than in the low performing teams (12 instances). This pattern shows a build up of decisions from period 1 to period 2 then a drop during period 3 when action on the decisions was taking place.

Table 6.22 - Decision Patterns for All Team

Dec Type	H1	L1	H2	L2	H3	L3	H4	L4
Total Dec	∨	\	∧	∧	∧	∧	∧	∨
Implicit	/	∨	∧	∧	∧	∧	¬	∨
Explicit	∨	\	∧	∧	∧	∧	∧	∨
Goal	/	\	/	/	∧	∧	∧	∨
Activity	∨	L	∧	∧	∨	∧	∧	∨
Challenge	∧	\	∧	∧	∧	\	∧	∨
Agreed	∨	∨	∧	∧	∧	∧	¬	∨

Note: See Table 6.7 for definition of symbols.

6.9.6. Discussion of Summaries

Analyses in previous sections showed that the teams were different in their decision-making process. This is consistent with the differences found (Chapter 5) in the communication between teams. These findings support Poole and Hirokawa's (1986) idea that through interaction, team members can draw out the best (and possibly the worst) each member has to offer. Each team member may offer something different and will therefore

> *create a resonance of ideas and a synthesis of viewpoints.*

Differences between the high performing teams and the low performing teams were found in the number of decisions made, the number of challenges made as opposed to the number of agreements made and the use of some of the decision methods. These differences showed although there were differences throughout all the teams, there were some working patterns within the high performing teams that helped to make them successful in their task. An example of this was in the methods used by each team. Method 1 (*decision by authority without discussion*) was used by more low performing teams than high performing teams. This draws attention to the type of leadership in each team. Chapter 8 discusses the differences in leadership styles.

Analyses also showed that most teams made more than 2/3 (66%) of their decisions in the first 2 periods. In software development terms this pattern suits the waterfall lifecycle as explained earlier where it would be expected that the greater number of decisions would be kept within periods 1 and 2 which coincide with the early lifecycle phases. These findings support Poole and Doelger, (1986) who state that each team member's representation of the task leads to the steps they take to solve the task. Groups make decisions based on the task management process. Chapter 7 discusses analyses on the software development processes used by the teams.

Chapter 7

The Software Development Process

7.1. Introduction

Chapter 5 of this thesis discussed the analysis carried out on the use and types of communication generated by the student teams in a software-development project. Chapter 6 then discussed decision-making process used within the project. This chapter investigates the software development processes used.

A common issue for most software development studies is that Information Technology (IT) is changing rapidly and therefore software development must keep up with the rapid changes. Arthur (1988) states that

> *As technology improves, software must evolve to match the technology... Software must evolve to meet the growing needs of these complex organizations and of people.*

In the 1970's software represented 20% of the main component of computer-based systems with hardware representing 80%. Changes in IT in the 1990s and 2000s have seen these roles reversed with software representing 80% of the main component of computer-based systems and hardware representing 20% (Bennatan, 2000).

The rapid changes in IT have also brought about challenges that threaten the success of software development projects. Many software projects face a range of challenges that eventually result in project delays (Hendrix and Schneider, 2002; Benamati and Lederer, 2001; Bennatan, 2000; Humphrey, 1997). Teasley, *et al* (2000) state that approximately two-thirds of software projects are late. Challenges that threaten the success of software development projects include problems with personnel resources, external factors beyond the control of the project team, and the software development process (Hendrix and Schneider, 2002; Benamati and Lederer, 2001).

Each team's software development process was identified via the communication and tracked along the project's timeline. The teams' decision-making process was revisited and compared with the software development process to identify patterns in key-decision points within the software development project. This chapter also looks at differences and similarities between the processes of the high performing groups and the low performing groups.

7.2. Analyses Design

Previous studies identified in Chapter 3, have investigated the software development process from varying aspects. Researchers have used techniques that range from metrics to measure the quality of programming (Curtis, 1980) to studying the impact of the communication medium on software development (Andres, 1996). Many methodologies involve investigation of the program constructs (the 'ifs', 'else then', loops or iterations' found in most programs) (Curtis, 1980; Basili and Reiter, 1979; Weinberg and Schulman, 1974).

Curtis (1980) identified two foci involved in software complexity. Computational complexity, which relies on formal mathematical analysis and psychological complexities, deals with understanding that software development is largely a human activity. Basili and Reiter (1979) and Pinto and Pinto (1990) also acknowledged the psychological nature of humans as having a role in the development of software and team success.

The techniques used for this research (explained in Chapter 4) involved investigation of each team's communication in the form of emails and internet relay chat (IRC) in order to identify the team's software development process. The patterns found in this investigation were derived from observation-based qualitative analysis. These analyses looked at each team's software development in terms of the waterfall lifecycle, the timing and duration of lifecycle phases by each team, the goal-oriented and activity-oriented decisions tracked alongside the software development and the effort in terms of time spent during the three-time periods.

Using inductive analysis, each team's communication was researched for threads that discussed the software development. A corresponding waterfall lifecycle phase (Figure 7.1) was assigned to each thread and logged electronically as a summary for each team's communication. This facilitated the flagging of the individual team's software development phases so they could be tracked and analysed along the project's timeline.

7.3. The Software Lifecycle in the Current Study

The **Waterfall model** was originally developed to show the life cycle of a project. It views the software process as a sequence of phases, which in turn can be divided into sub-phases. Each phase is identified, *signed off* and development then proceeds to the next phase. Originally each phase was considered to be distinct. However, it was found that, in practice, this process was not linear, and the phases tended to overlap and feed information to other phases (Sommerville, 2000). Additionally, information found in later phases required rework in previous phases. It was therefore recognised that the Waterfall model consisted of <u>iterations and increments</u>. Figure 7.1 shows a simple form of the Waterfall model with iterations.

An iterative process...involves the successive refinement of a system's architecture, from which we apply the experience and results of each major release to the next iteration of analysis and design... The process is incremental in the sense that each pass...leads us to gradually refine our strategic and tactical decisions, extend our scope from an initially skeletal architecture, and ultimately lead to the final, deliverable software product (Booch, 1996).

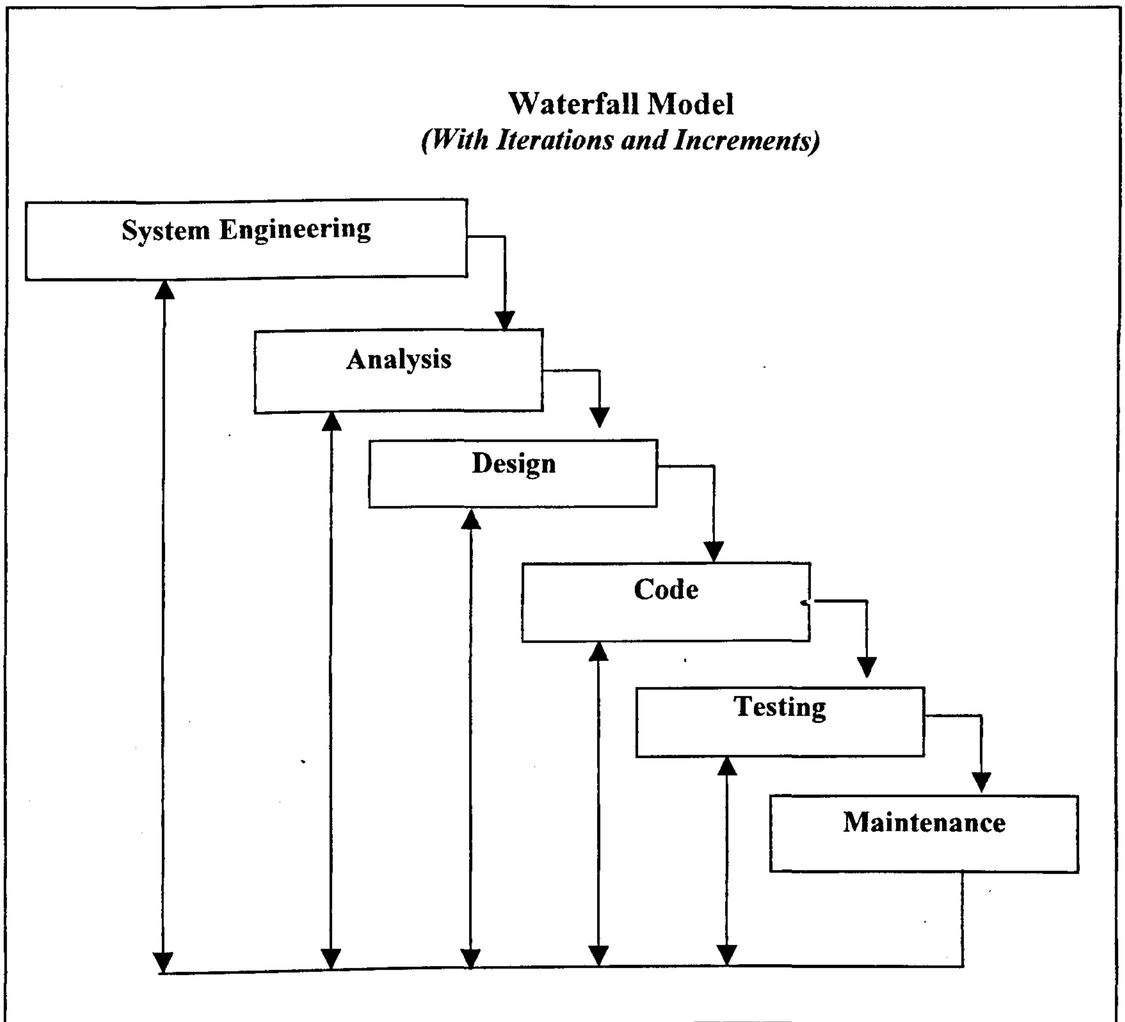


Figure 7.1 - The Waterfall Model with Iterations and Increments - Pressman (1992)

The Waterfall model stages were identified as follows:

System Engineering – Establishment of requirements for all system elements and allocating a subset of these requirements to software. Includes defining their process and the needs of the customer as well as planning and management.

Analysis – Requirements gathering process focused and intensified specifically on software. Includes definition of the system that meets the customer needs.

Design – Translation of requirements into a representation of the software. Includes how the system will be implemented.

Code – Design translated into machine-readable form. Also includes unit or early testing.

Testing – Testing process focuses on the internals of the software. This is the full or final testing of the system.

Maintenance – Adaptation of the software to accommodate changes due to errors or enhancements.

This research examined a group's software development process in terms of the stages identified in the Waterfall software development model above. Table 7.1 below shows the course's project milestones with the corresponding waterfall lifecycle phases.

Table 7.1 - Project Milestones with Corresponding Waterfall Phase

Milestone	Milestone Deliverable	Waterfall Lifecycle Phase
M1	Requirements Gathering. Team Building Exercise	System Engineering
M2	Design Document	Analysis and Design
M3	Motor Control.	Code and Unit Test
M4	Video Processing	Code and Unit Test
M5	Project progress and Server	Code and Unit Test
M6	Navigation and Integration	Code and System Test
M7	Client/Server Communication	Maintenance and System Test
	Final Presentation	Maintenance

It is important to note that the Maintenance phase normally continues after the project has been completed. However, as this research had a limited time span, the maintenance phase was concluded once the presentations were completed.

7.4. Time Estimate of Lifecycle Phases

Although in general, software development process models or lifecycles have specified named phases, there is no specific single breakdown of the development path. The most important element of a good breakdown is completeness in order to produce the project's required deliverables (Birrell and Ould, 1985).

Each phase of any lifecycle regardless of iteration or not, will have a list of activities required and a clear start and clear end in order to know what needs to be done, when it has started and when it is completed. Phases also do not have set time lengths. According to Hendrix and Schneider (2002), lifecycles that have specified time frames for each activity can force teams into not addressing important activities and therefore not meeting the scheduled deadline.

Many researchers (Basili and Reiter, 1979; Birrell and Ould, 1985; Pressman, 1992; Sommerville, 2000; Brooks, 1995; Bennatan, 2000 and Humphrey, 2000) have studied the issue of time estimation for lifecycle phases. Bennatan (2000) identifies different percentage breakdowns for different types of systems and groups the lifecycle phases under the categories of

- **Planning,** - includes requirements gathering, analysis and design.
- **Code and unit test** - includes coding and early testing.
- **Integration and test** - includes the total integration and final testing.

In presenting time estimations, other researchers group the phases slightly differently but all take into account the necessary activities such as requirements gathering, analysis, coding, testing and integration. In order to get a range of time estimates for the lifecycle phases, this research used Bennatan's (2000) grouping of **planning, code and unit test** and **integration and test** as a guide. The mean average was taken for each researcher's (Basili and Reiter, 1979; Birrell and Ould, 1985; Pressman, 1992; Sommerville, 2000; Brooks, 1995; Bennatan, 2000 and Humphrey, 2000) time estimates for the lifecycle phases and grouped using Bennatan's categories. A range of the percentage of time spent on each grouping was as follows.

Category grouping	Range of percentage of time spent
Planning	25% - 46%
Code and unit test	20% - 42%
Integration and test	25% - 35%

The percentages above are representative of a broad range of software project types rather than specific project types. Looking at the highest estimated percentage of time, the first category has the highest percentage with a slight decrease into the second category and a further decrease during the last category. This was consistent with Basili and Reiter (1979) and Scott and Simmon's (1975) findings that a large portion of time and effort is spent in the early stages of a project during the **exploratory** period then there is a decrease towards the end of the project. Vasudevan (1996) suggests that the software development process involves reducing uncertainties over time. As uncertainties are addressed, the percentage of time spent decreases as the project progresses. For this study, Bennatan's (2000) grouping will also be used when looking at the percentage of time spent on the lifecycle phases by each of the 8 teams involved.

7.5. Teams' Software Development Lifecycles

The waterfall lifecycle is sequential in that each phase begins one after the other. It is iterative, however because each phase requires some input from the previous phase, it does not require completion of the previous phase.

It was therefore expected that each team had a progression of phases that begin one after the other showing increments or information passed from one phase to the next. With iteration, it was also expected to see phases re-visited throughout the project timeline.

A project having a 9 week lifecycle is somewhat limited so much of the work such as designing, coding and testing would be done at the same time therefore showing continuous or re-visited phases. Even with a short project, it would be expected that the early or preparatory phases such as system engineering (SE) and analysis would not be used continuously throughout the project lifecycle but would have short re-visited periods of iteration.

7.5.1. Development Process Comparison Across All Teams

Figure 7.2, Figure 7.3, Figure 7.4, Figure 7.5, Figure 7.6, Figure 7.7, Figure 7.8 and Figure 7.9 below show each team's individual software development lifecycle across the project's timeline of 9 weeks.

- The lifecycle phases were individually represented in each team's graph by a series of bars beginning and ending during the corresponding weeks.
- Along with the software lifecycle, the project milestones have also been represented at the top of the graph to show where they are placed in the project's timeline.
- Each team's goal-oriented and activity-oriented decisions were represented via a line graph across the project's timeline and superimposed over the lifecycle bar graph.
- The use of goal-oriented and activity-oriented decisions in this analysis was because they were more relevant to key-decisions in the software development process.
- The lifecycle phase's labels were placed to the right of the graph and the decision occurrences and labels were placed to the left of the graph.
- The teams were identified in the graph's title with the team number and either an 'L' for low performing or 'H' for high performing.

In order to aid analysis throughout time, along with the individual project weeks (placed at the bottom of the graphs), the weeks were sectioned into three periods (also placed at the bottom of the graphs). The rationale for this was taken from previous research conducted on time estimation for lifecycle phases described in section 7.4 (Bennatan, 2000; Humphrey, 2000; Brooks, 1995; Pressman, 1992; Sommerville, 2000; Birrell and Ould, 1985; Basili and Reiter, 1979).

The three-time periods cover the same weeks and tasks as those discussed in Chapter 6. Because Bennatan's (2000) grouping (***planning*, *code and unit test*** and ***integration and test)*** was used as a guide for time estimation, each period was been translated into

Period 1 (P1) =*planning.*

Period 2 (P2) =*code and unit test.*

Period 3 (P3) =*integration and test.*

This study looked at the 8 teams' software development process and plotted each phase against the project's timeline. Previous analyses in Chapter 5 and Chapter 6 have shown differences in the amount of communication and decisions between all 8 teams and between the total high performing groups and the total low performing groups. Although the task and time line was the same for all teams, the timing and use of the software lifecycle was expected to be different because each team may have taken a different approach. Differences were expected in the use of the software development lifecycle between the high performing groups and the low performing groups. The question for this observation is

Question

Q - were there differences in the use of the software development process between the high performing groups and the low performing groups?

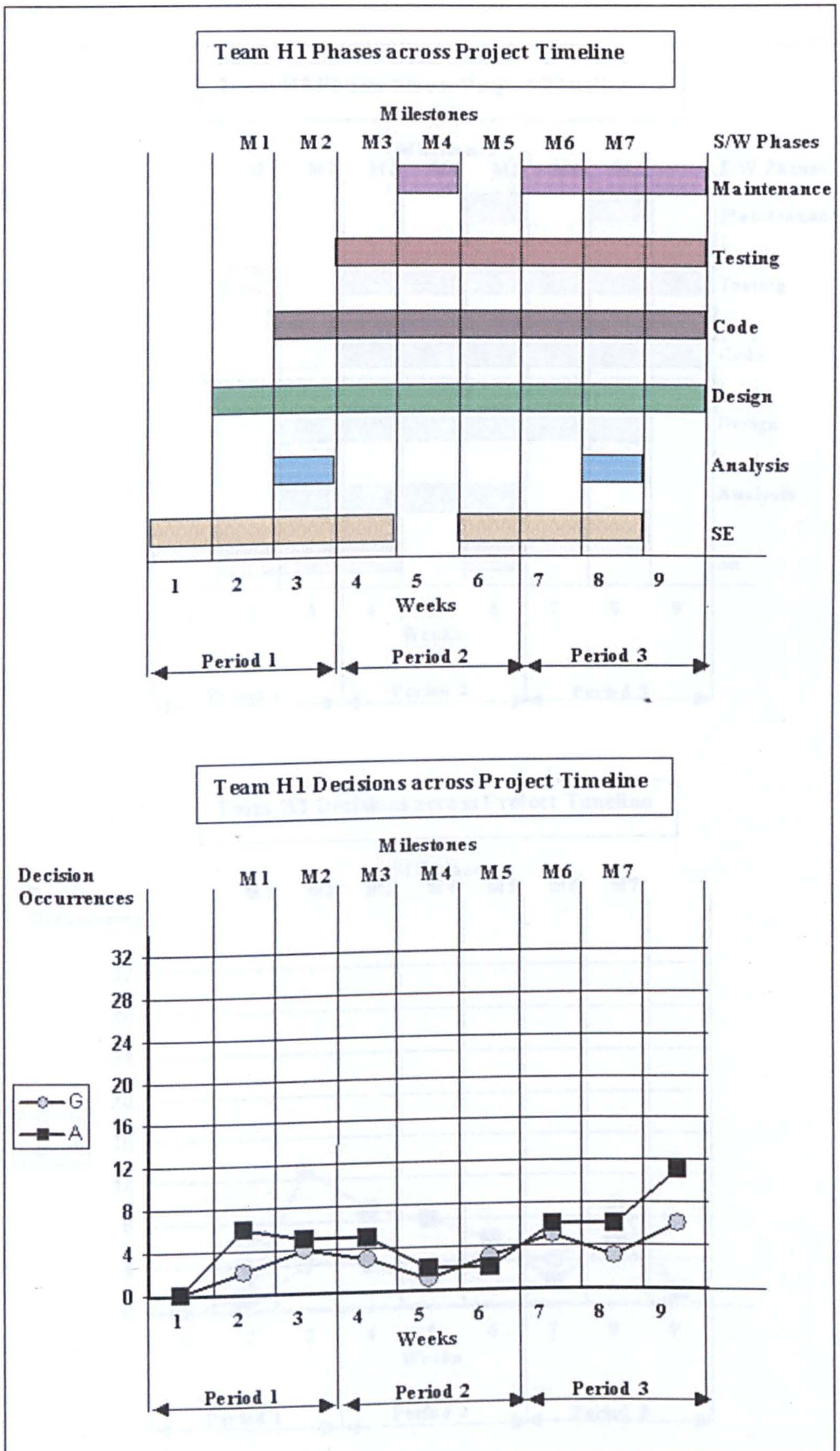


Figure 7.2 - Team H1Phases and Decisions across Project Timeline

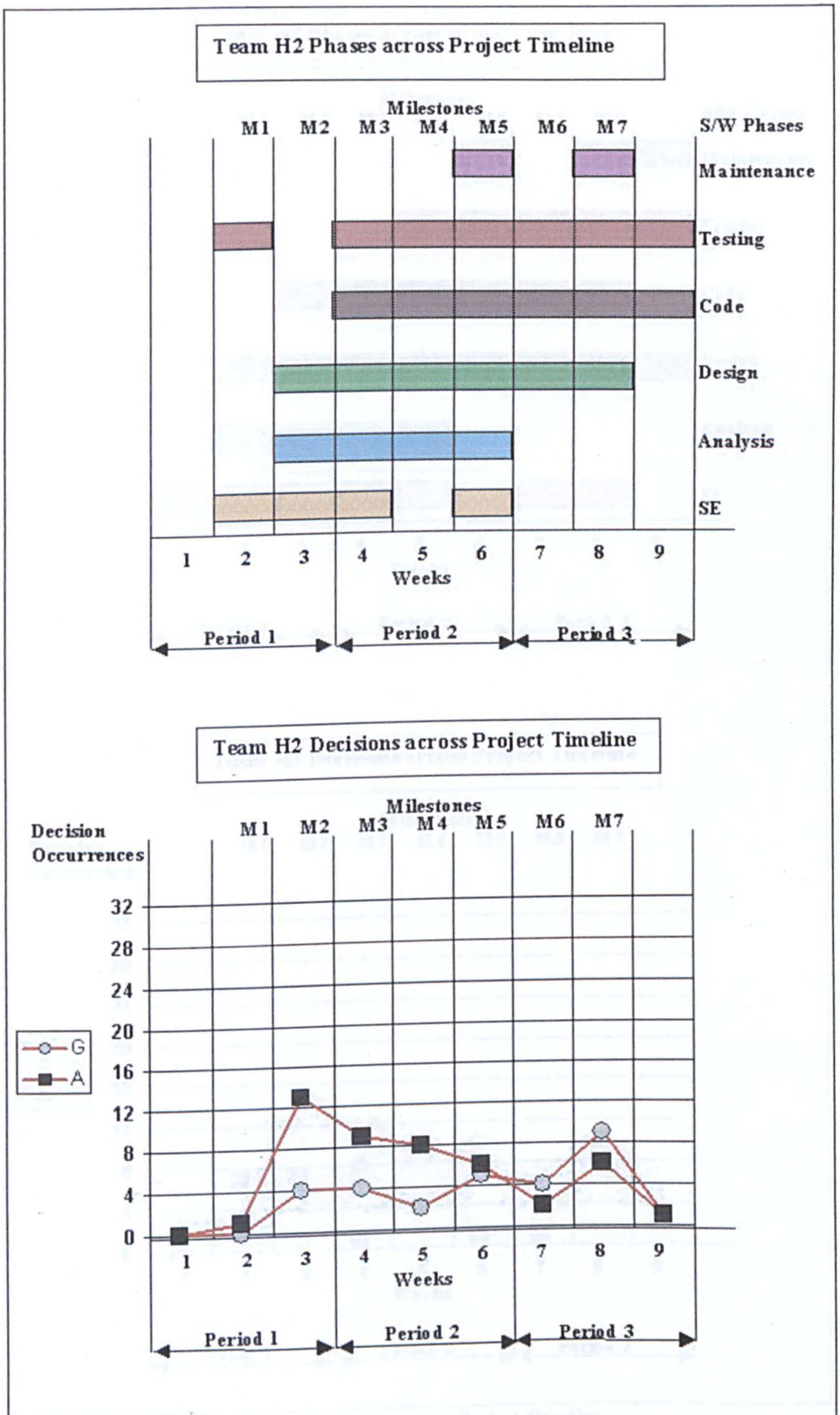


Figure 7.3 - Team H2 Phases and Decisions across Project Timeline

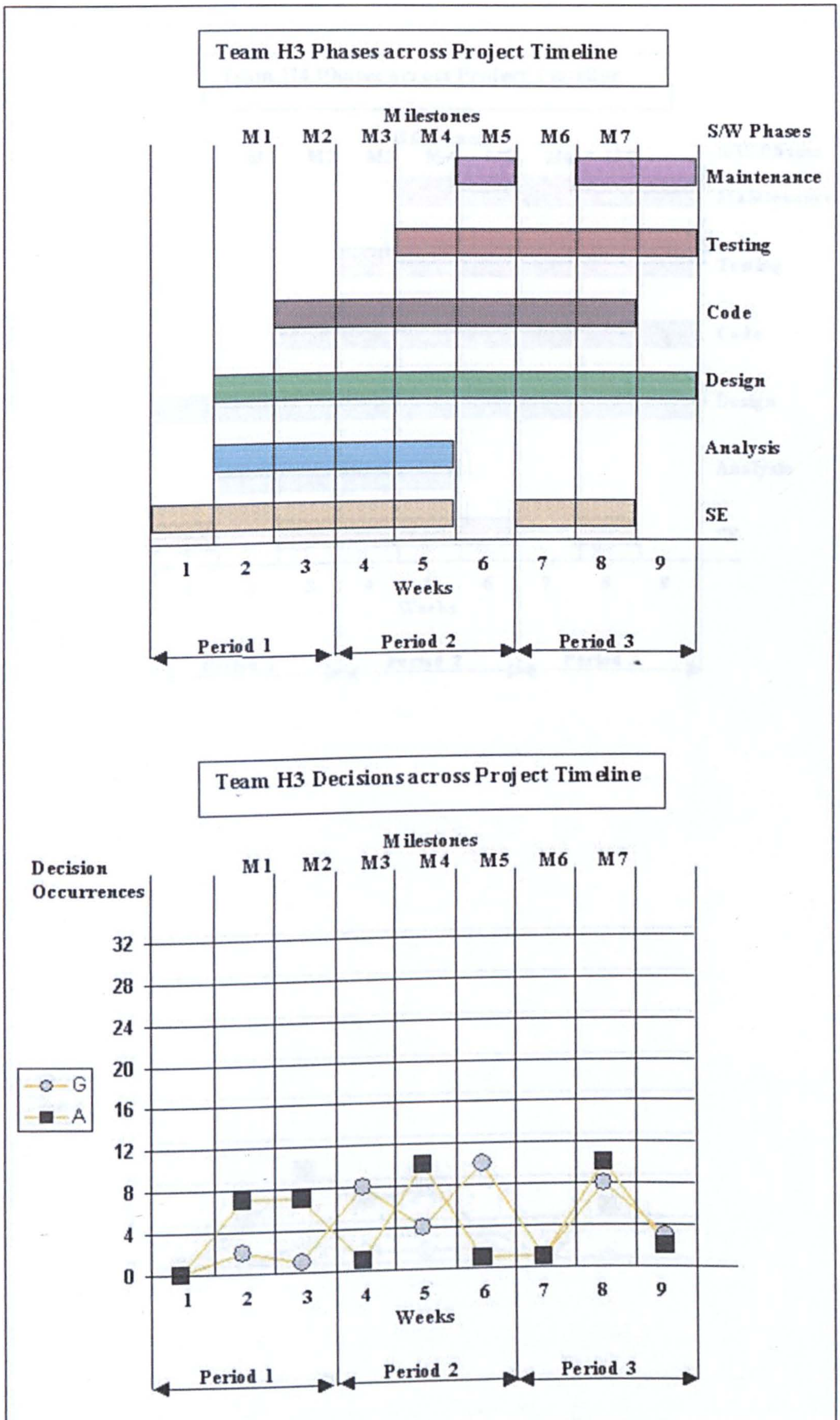


Figure 7.4 - Team H3 Phases and Decisions across Project Timeline

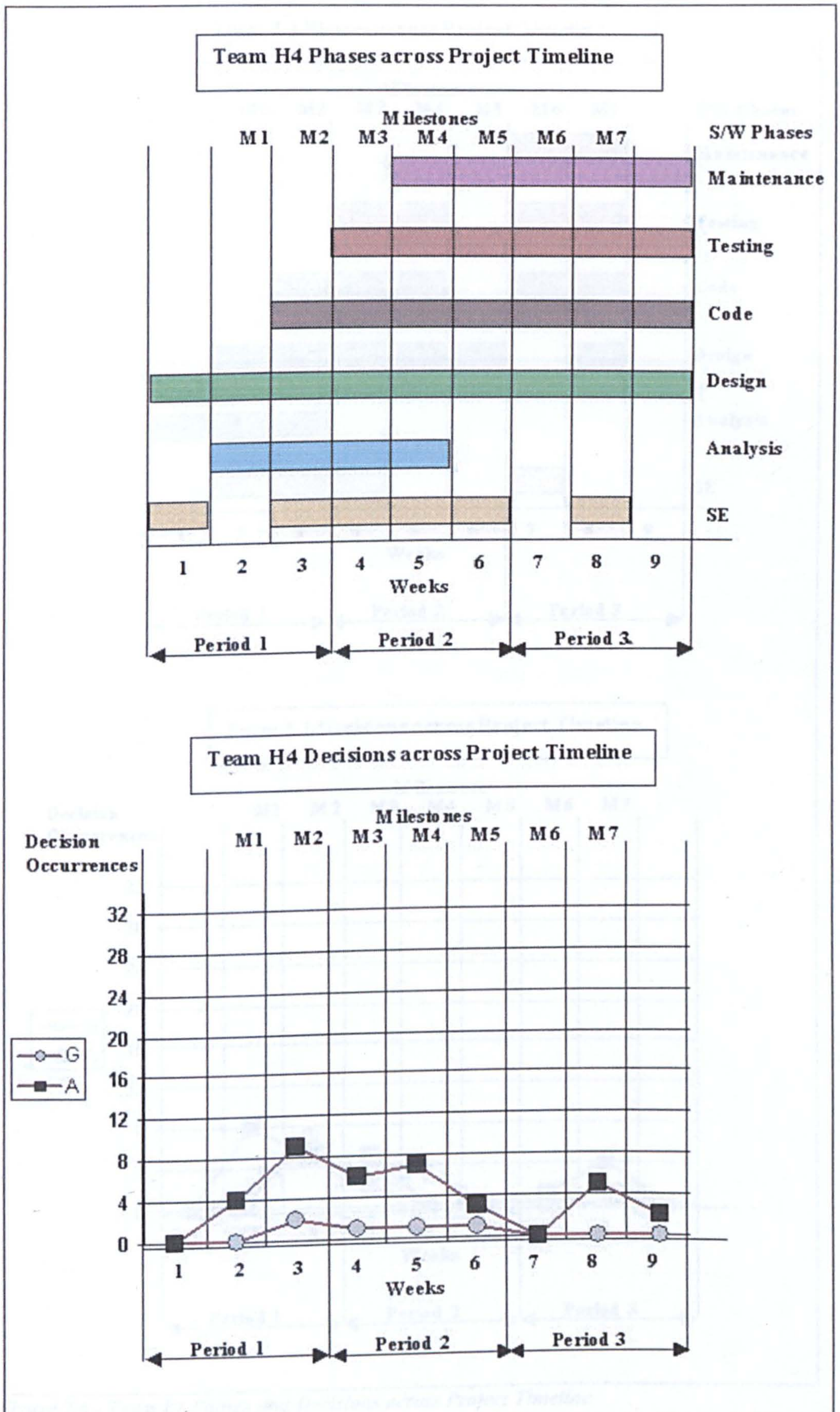
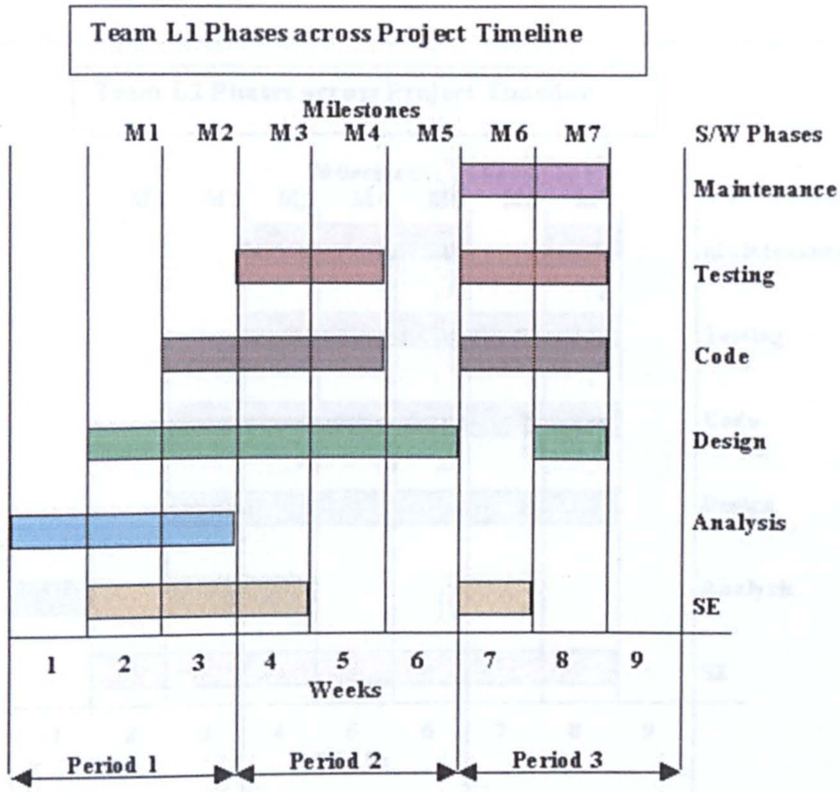


Figure 7.5 - Team H4 Phases and Decisions across Project Timeline



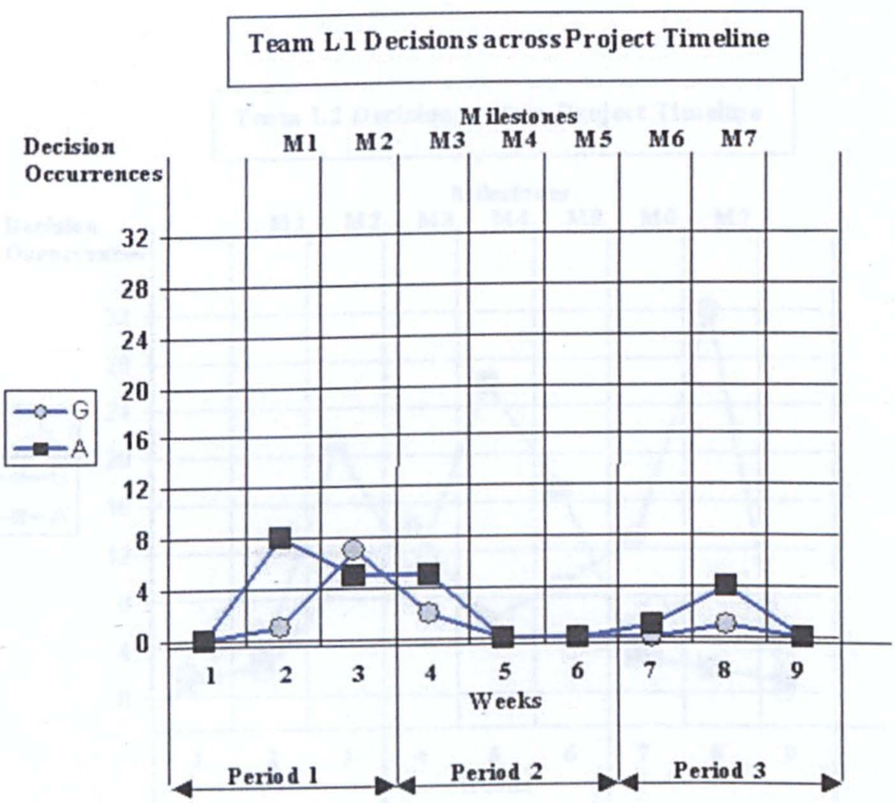


Figure 7.6 - Team L1 Phases and Decisions across Project Timeline

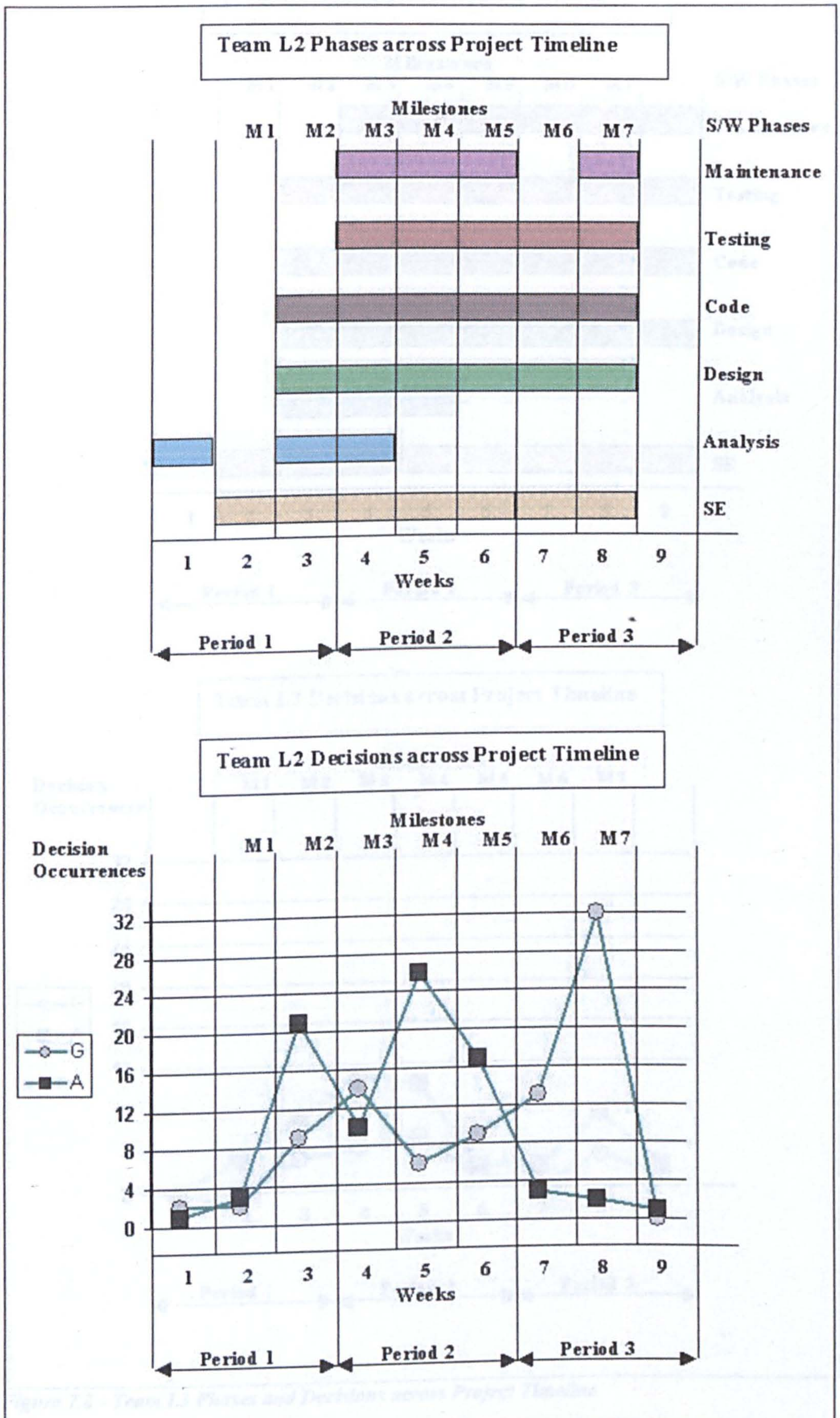


Figure 7.7 - Team L2 Phases and Decisions across Project Timeline

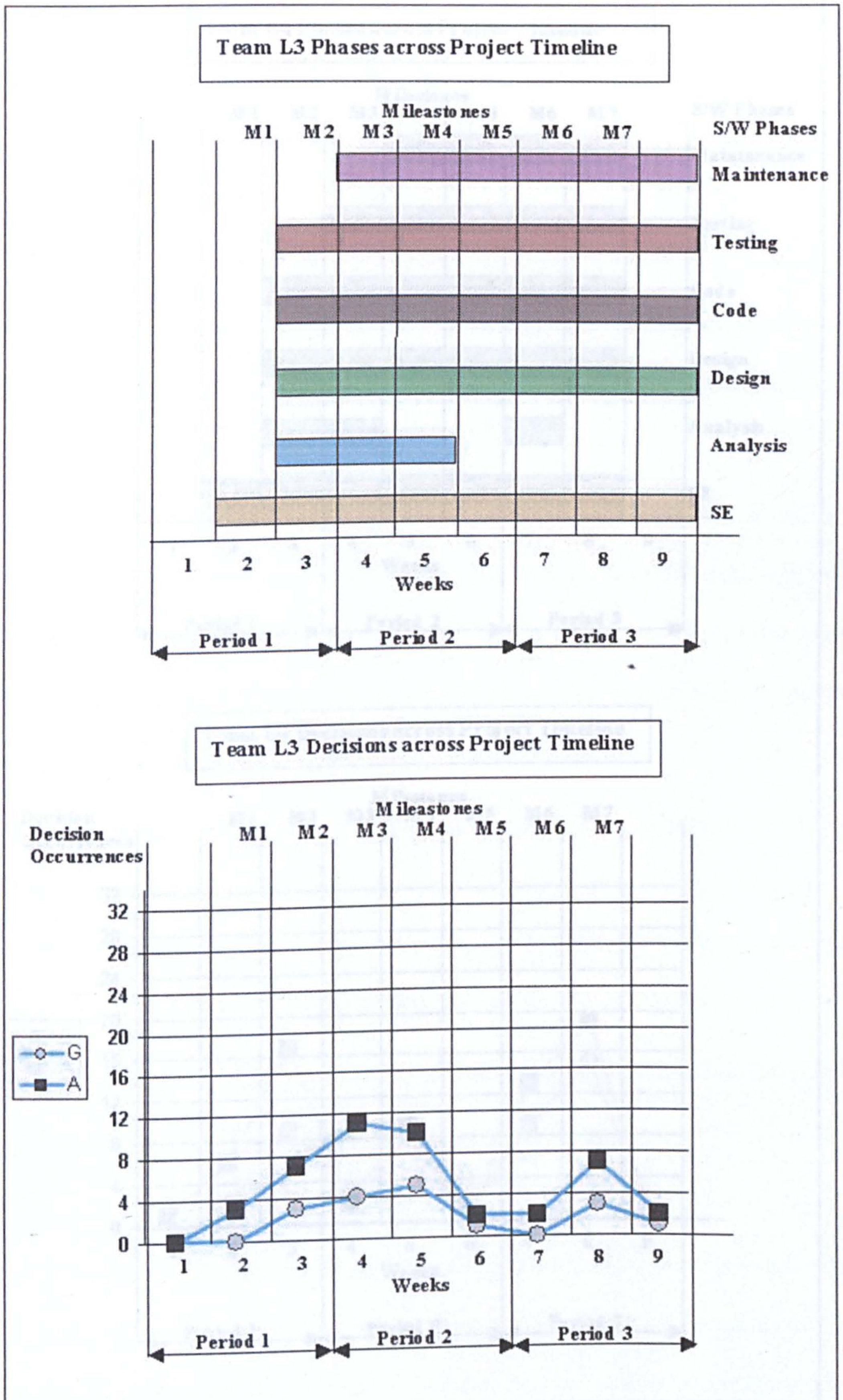


Figure 7.8 - Team L3 Phases and Decisions across Project Timeline

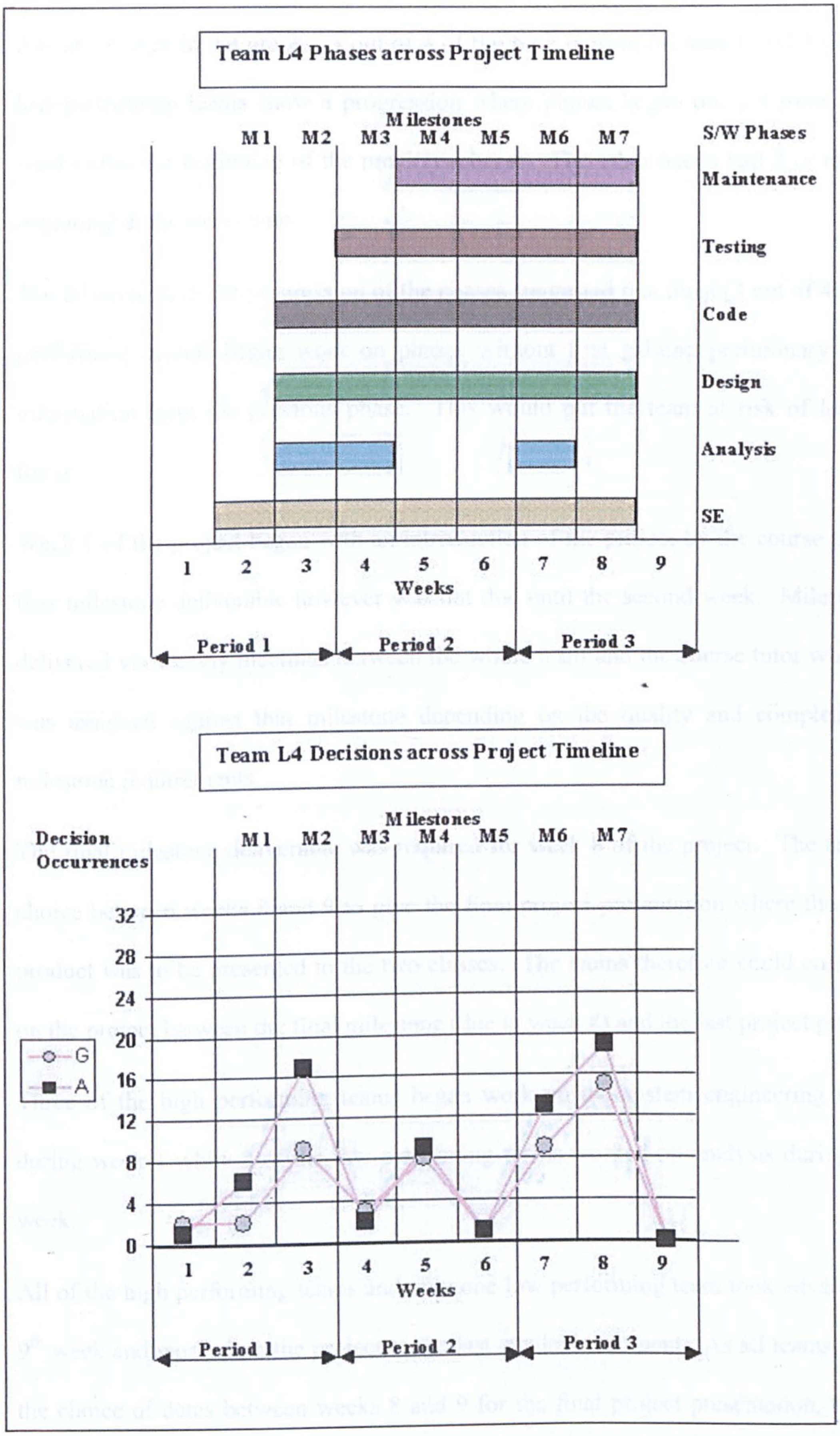


Figure 7.9 - Team L4 Phases and Decisions across Project Timeline

As can be seen in the graphs, 3 out of 4 of the high performing teams and 1 out of 4 low performing teams show a progression where phases began one (in some cases two) weeks after the beginning of the previous phases. The other teams had 2 or more phases beginning at the same time.

The differences in the progression of the phases suggested that most (3 out of 4) of the low performing groups began work on phases without first gaining preliminary and useful information from the previous phase. This would put the team at risk of losing initial focus.

Week 1 of the project began with an introduction of the project by the course tutors. The first milestone deliverable however was not due until the second week. Milestones were delivered via weekly meetings between the whole team and the course tutor where a mark was assigned against that milestone depending on the quality and completion of the milestone requirements.

The final milestone deliverable was required for week 8 of the project. The teams had a choice between weeks 8 and 9 to give the final project presentation where the completed product was to be presented to the two classes. The teams therefore could continue work on the project between the final milestone (due in week 8) and the last project presentation.

Three of the high performing teams began work on the system engineering (SE) phase during week 1 while 2 of the low performing teams worked on analysis during the same week.

All of the high performing teams and only one low performing team took advantage of the 9th week and worked on the project to the last available moment. As all teams were given the choice of dates between weeks 8 and 9 for the final project presentation, the analysis suggested that the low performing group did not consider all options when scheduling the project. Sections 7.5.2, 7.5.3, 7.5.4 discuss in further detail the beginning, ending and duration of each phase for each group.

Result

There were differences in the use of the software development between the high performing groups and the low performing groups. One example of these differences is that more of the low performing groups worked on the SE phase throughout the project thus suggesting that the high performing groups were more focused in scheduling tasks. The following sections will discuss this in further detail.

7.5.2. Phase Comparison Across All Teams

The previous section analysed each team's full software development lifecycle. This section investigated the movements of each phase in terms of when each phase began, how long it lasted and whether or not it had a continuous use (**sequential**) or if it had broken periods of use (**segmented**). It was expected that there would be differences in the patterns of phases between the high performing groups and the low performing groups. The question for this observation is

Question

Q - were there differences in phase patterns between the high performing groups and the low performing groups?

Table 7.2 below shows a summary of the movement of each phase for all the teams.

Each lifecycle phase, has a section in the table that has a column for

- S = start week - the week number in the project timeline of when the phase began.
- # = number of weeks - the total length of the phase in weeks.
- Q = sequential (Y = yes, it was sequential or continuous, N = not sequential but segmented or in broken periods)

Table 7.2 - Lifecycle Phase Movement for Each Team

T	SE			Analysis			Design			Code			Test			Maint		
	S	#	Q	S	#	Q	S	#	Q	S	#	Q	S	#	Q	S	#	Q
H1	1	7	N	3	2	N	2	8	Y	3	7	Y	4	6	Y	5	4	N
L1	2	4	N	1	3	Y	2	6	N	3	5	N	4	4	N	7	2	Y
H2	2	4	N	3	4	N	3	6	Y	4	6	Y	2	7	N	6	2	N
L2	2	7	Y	1	3	N	3	6	Y	3	6	Y	4	5	Y	4	4	N
H3	1	7	N	2	4	Y	2	8	Y	3	6	Y	5	5	Y	6	3	N
L3	2	8	Y	3	3	Y	3	7	Y	3	7	Y	3	7	Y	4	6	Y
H4	1	6	N	2	4	Y	1	9	Y	3	7	Y	4	6	Y	5	5	Y
L4	2	7	Y	3	3	N	3	6	Y	3	6	Y	4	5	Y	5	4	Y
HAve#		6			3.5			7.75			6.5			6			3.5	
L-Ave#		6.5			3			6.25			6			5.25			4	
Diff		0.5			0.5			1.5			0.5			0.75			0.5	

- <u>System engineering *(SE)*</u> phase began for 3 out of 4 of the high performing teams during week 1. All of the low performing teams in addition to 1 high performing team began work on this phase during week 2.

  The average mean for the number of weeks of SE used by the high performing groups was 6 weeks and for the low performing groups was 6.5 weeks.

  Three of the low performing teams had a sequential use of SE throughout the project timeline whereas all of the high performing groups and one low performing group had a segmented use of SE.

- **Analysis** phase began during weeks 1-3 with no distinguishing pattern between the high performing groups and low performing groups.

  The average mean for the number of weeks of used by the high performing groups was 3.5 weeks and for the low performing groups was 3 weeks.

  There was an even breakdown of 2 and 2 for the high performing groups and low performing groups regarding the sequential or segmented use of the analysis phase.

- **Design** phase start week ranged from weeks 1-3 for the high performing groups while three of the low performing teams started analysis during the 3rd week and the fourth low performing team started during week 2.

  The average mean for the number of weeks of use of the analysis phase by the high performing groups was 7.75 and 6.25 for the low performing groups.

  All teams but one low performing team had sequential use of the design phase.

- **Coding** began during week 3 for all of the low and 3 of the high performing groups. The fourth high performing group began coding during week 4.

  The average mean for the number of weeks of coding by the high performing groups was 6.5 weeks and 6 weeks for the low performing groups.

  All of the high performing teams and three of the low performing teams had a sequential use of the coding phase.

- **Test** plans were required as a deliverable for milestone 3 (week 4), however unit testing was done as an iteration process early on by several teams. The starting week for *testing* ranged from weeks 2-5 for the high performing groups and weeks 3-4 for the low performing groups.

  The average mean for the number of weeks of testing for the high performing groups was 6 weeks and 5.25 weeks for the low performing groups.

  Three of the high and 3 of the low performing teams used the testing phase sequentially throughout the project timeline.

- **Maintenance** for this project encompasses the changes due to errors or enhancements worked on during the project timeline. The starting week for the *maintenance* phase had an even breakdown of weeks 5 and 6 for the high performing groups and a range of weeks 4-7 for the low performing groups. The majority of maintenance is usually carried out well after a project is completed.

  The average mean for the number of weeks of maintenance was 3.5 weeks by the high performing groups and 4 weeks for the low performing groups.

  Three of the high performing teams had segmented use of the maintenance phase while three of the low performing teams had sequential use.

Start Week

It became obvious from analysing the communication scripts that part of the reason why some teams began work at a later time was because during weeks 1 and 2 they were not sure what the project entailed. There were no notable differences in the start weeks for most phases. System engineering (SE) and analysis were the only exceptions. Most (3 out of 4) of the high performing groups began SE and therefore planning earlier than the low performing groups. One of the high performing groups began design in week 1. Half of the low performing groups began analysis during the first week suggesting this as too early if they were unsure about the project details.

Number of Weeks

The duration of phase use again did not show any notable differences between the high and low performing groups. The high performing teams had a slightly higher use of 4 phases (analysis, design, code and testing) however the differences were minimal. The range of differences in the average mean was between 0.5 and 1.5 weeks. Four of the phases had a difference of 0.5 weeks between the high performing teams and low performing teams. The highest difference in the average mean use of phases was 1.5 weeks with the high performing groups having the higher use of design.

Sequential or Segmented

The differences found between the high performing teams and low performing teams' sequential or segmented use of phases were within the SE and maintenance phases. All the high performing teams had a segmented use of SE while 3 of the low performing teams had a sequential use of SE. Three of the high performing teams also had a segmented use of the maintenance phase while three of the low performing teams had a sequential use. This suggested that the high performing groups revisited these phases when it was necessary rather than spending time on them when it was not necessary. The sequential use of SE by the low performing groups also shows a lack of focus in that they required continuous planning and re-establishment of requirements.

Result

Although there were no notable differences in the duration of use of phases between the high performing groups and the low performing groups, there were differences in the starting week and the sequential or segmented use of some phases.

7.5.3. Lifecycle Phases and Decisions

Project goals were identified in this analysis as the product set to be delivered on a weekly basis or the final project outcome. **Goal-oriented** decisions were seen as those decisions that were directly related to a project goal. An **activity-decision** was one that related to the actions or steps taken in achieving the goal or deliverable, but not directly related to a goal or deliverable (Chapter 6).

Each team's goal-oriented and activity-oriented decisions were included in Figure 7.2, Figure 7.3, Figure 7.4 and Figure 7.5 for comparison against each team's software development process.

Chapter 6 discussed the analysis of the goal-oriented and activity-oriented decisions in terms of differences in their use between the high performing groups and the low performing groups and differentiating patterns through time. This analysis again looked at differences between the high performing groups and the low performing groups and patterns through time. However in this case, observations were made as to how they related to the software development phases. It looked at what was happening in the software development process during the high decision-making periods.

Previous sections observed a lack of focus from the low performing groups in the start and number of phases they worked on at a specific point in time. The question for this observation is

Question

Q - were there differences between the high performing groups and the low performing groups in the number of phases worked on during high decision points?

Across Time

- The patterns across time for both the goal-oriented and activity-oriented decisions were similar.
- There were more activity-oriented than goal-oriented decisions in 3 of the high and 3 of the low performing groups especially in periods 1 and 2.
- The general goal-oriented and activity-oriented decision patterns did not make any distinctions between the high performing groups and low performing groups. These findings were consistent with the findings on goal-oriented and activity-oriented decisions in Chapter 6.

Goal-oriented

- The highest number of goal-oriented decisions for the high performing groups was during weeks 3, 6, 8 and 9 thus covering all three periods.
- All high performing groups worked on 4 different software lifecycle phases during the weeks where the highest goal-oriented decisions were made.
- The highest goal-oriented decisions for the low performing groups occurred during weeks 3, 5, and 8, again covering all three periods.
- The number of different software lifecycle phases that the low performing groups worked on during the highest goal-oriented decision points ranged from 4-6.

Activity-oriented

- The highest number of activity-oriented-decisions for the high performing groups was seen during weeks 3, 5, and 8 covering all three periods.
- The number of software lifecycles worked on by the high performing groups ranged between weeks 3-5.

- The highest number of activity-oriented decisions for the low performing groups occurred during weeks 2, 4, 5, and 8 again covering periods 1, 2, 3.
- The number of software lifecycle phases worked on by the low performing groups during the highest activity-oriented decisions ranged between 3-6.

The highest number of activity-oriented and goal-oriented decisions occurred during weeks 2-9 and covered all three periods for all the teams, both high and low performing. This suggested that all the teams were different in the way they made goal-oriented and activity-oriented decisions. This was also shown in Chapter 6. There were no patterns in the timing of activity-oriented or goal-oriented decisions that differentiated between the high and low performing groups.

Result

During the week when the most activity-oriented and goal-oriented decisions were made, the high performing teams were working on a different number of phases than the low performing teams This again suggests that the high performing groups were more focused in scheduling tasks.

7.5.4. Common Phases During High Decision Points

Although there were differences in the number of lifecycle phases worked on during the highest activity-oriented and goal-oriented decision-making, these differences were minimal. Decision points in this study refer to a point in the time of the project, in this case, a specific week. During the highest goal-oriented decision points, each of the high performing teams worked on 4 different phases while the low performing teams each worked on an average mode of 5 phases. Using the high performing groups' 4 phases as a guide, it should be noted that 3 of the 4 low performing teams worked on more than 4 phases during the highest goal-oriented decision points.

The number of phases worked on by the high performing groups during the highest activity-oriented decision points had an average mode(the number that occurs most often) of 4 phases. Only one of the high performing teams had more than 4 phases. The number of phases worked on by the low performing teams during their highest activity-oriented decisions had an average mode of 5 phases. Three out of four of the low performing teams again worked on more than 4 phases.

Design and *code* were the phases common to all high performing teams during the high goal-oriented decision-making points. *Design* alone was the common phase during their highest activity-oriented decision points.

SE, Design and *code* were the phases common to all the low performing groups during the highest goal-oriented decision-making points. *Design* and *SE* were the common phases worked on by all the low performing teams during the highest activity-oriented decision points.

Along with the design phase, the SE phase was common to all low performing teams during the highest number of activity-oriented and goal-oriented decisions. It was expected to find the design phase during high decision points because using iteration, the teams would revisit the design several times to ensure validity and verification.

The high number of software lifecycle phases worked on during high decision points and the consistency of the SE phase as common among all low performing teams, showed that they were working on several aspects of the software development as well as trying to re-establish their requirements. Analysis showed that while designing, coding, testing, etc., the low performing teams seemed to have lost focus and had to go back and re-assess and re-define their process which also accounted for this being the point of their highest decision-making.

Result

The differences between the high performing groups and low performing groups in the number of software lifecycle phases worked on during high decision points suggested a lack of focus by the low performing groups.

7.6. Percentage of Time Compared Between High Performing Groups and Low Performing Groups

Table 7.3 below illustrates percentages of use of the lifecycle phase for each team's work effort. Each team's effort in the form of a percentage is placed below each time period.

According to time estimates calculated in section 7.4,

Planning should have between 25% - 46% of the effort.

Code and unit test should have between 20% - 42% of the effort.

Integration and test should have between 25% -35% of the effort.

Analyses in previous sections (7.5.2,7.5.3,7.5.4) suggested that there were differences in the software development lifecycle between the high performing groups and the low performing groups. Analysis in this section looked at the effort in terms of time percentage spent on the software development tasks outlined below. The question for this observation is

Question

Q - were there differences between the high performing groups and the low performing groups in the breakdown of percentage of time spent on specific software development

Comparison of the work involved in each of the waterfall lifecycle phases along with the work involved in Bennatan's grouping (section 7.5.1), the corresponding lifecycle phases to the grouping are as follows:

Planning – SE, Analysis, Design.

Code and Unit Test – Code and Test (test covering periods 1-**P1** and 2-**P2**).

Integration and Test - Test (test period 3-**P3**) and Maintenance.

Table 7.3 - Lifecycle Phase Percentages for Ecah Team

Team	Planning (SE, Analysis, Design)			Code and Unit Test (Code and Test-P1and2)			Integration and Test (Test P3 and Maint)		
	P1	P2	P3	P1	P2	P3	P1	P2	P3
H1	17%	14%	**20%**	1%	**12%**	5%	0%	0%	**30%**
L1	**49%**	19%	4%	2%	**11%**	4%	0%	0%	**9%**
H2	18%	**25%**	6%	1%	**24%**	12%	0%	1%	**14%**
L2	15%	**19%**	8%	0%	**34%**	5%	0%	3%	**15%**
H3	18%	**27%**	12%	0%	**15%**	9%	0%	1%	**17%**
L3	15%	**23%**	6%	2%	**20%**	12%	0%	4%	**20%**
H4	12%	**29%**	7%	1%	**17%**	14%	0%	4%	**16%**
L4	15%	19%	12%	1%	**13%**	**13%**	0%	2%	**24%**

The largest amount of effort in each section (**planning**, **code and unit test**, **integration and test**) is highlighted in **bold** in the table above.

Because the work undertaken for **planning** began early in the lifecycle, they were expected to show more effort during period 1 (**P1**).

- Only 1 (low performing team) showed the greatest amount of effort during period 1. The greatest amount of effort for the rest of the teams except the team mentioned above and one high performing team was seen during period 2 (**P2**).
- Three of the high performing teams had percentages of work that fell within the estimated percentage range.

The work undertaken for **code and unit test** began later in the lifecycle therefore the greatest amount of effort for code and unit test was expected during the second period **(P2)**.

- All of the teams showed the greatest amount of code and unit test during the second period.
- Team L4 (low performing) had the same percentage of effort for code and unit test during periods 2 and 3.
- Two of the low performing teams and one high performing team had percentages of work that fell within the estimated percentage range.

Integration and testing began after coding was carried out; therefore the greatest amount of effort here was expected during period 3 **(P3)**.

- This was true for all of the teams with only one staying within the estimated range.

Although the most effort was expected in the specific tasks according to where it began in the lifecycle, it was also expected that there would be some amount of effort during other periods because of iteration. This would account for why only some of the teams in this study stayed within the recommended percentage.

Result

The result was inconclusive because there were differences between the high performing groups and the low performing groups in only one of the three observed periods.

7.7. Chapter Summary

Previous chapters found differences between the high performing groups and low performing groups in their total communication and decision-making patterns. This chapter investigated the software development process of each team in terms of the waterfall lifecycle, the timing and duration of lifecycle phases by each team, the goal-oriented and activity-oriented decisions tracked alongside the software development and the effort in terms of time spent during a three-time period. With the use of observation-based qualitative analyses, some differences between the high performing groups and the low performing groups in their software development process were found.

7.7.1. Differences in Phases

It became obvious from analysing the communication scripts that part of the reason why some teams began work at a later time was because during weeks 1 and 2 they were not sure what the project entailed.

Most (3 out of 4) of the high performing teams began SE and therefore planning earlier than the low performing groups. Half of the low performing groups began analysis during the first week suggesting this as too early if they were unsure about the project details.

The range of differences in the average mean was between 0.5 and 1.5 weeks. Four of the phases had a difference of 0.5 weeks between the high performing groups and low performing groups. The highest difference in the average mean use of phases was 1.5 weeks with the high performing groups having the higher use of design.

The differences found between the high performing groups and low performing groups' sequential (continuous) or segmented (iterated) use of phases are within the SE and maintenance phases. All of the high performing groups had a segmented use of SE while 3 of the low performing groups had a sequential use of SE. Three of the high performing groups also had a segmented use of the maintenance phase while three of the low performing groups had a sequential use. In other words, the high performing groups had more iteration than the low performing groups.

This suggested that the high performing groups revisited these phases when it was necessary rather than spending time on them if it was not necessary. The sequential use of SE by the low performing groups also shows a lack of focus in that they required continuous planning and re-establishment of requirements.

7.7.2. Goal-oriented and Activity-Oriented Decisions and Phases

The general goal-oriented and activity-oriented decision patterns did not show any distinctions between the high performing groups and low performing groups. The highest number of activity-oriented and goal-oriented decisions occurred during weeks 2-9 and covered all three periods for all the teams, both high performing and low performing. This suggested that all the teams were different in the way they made goal-oriented and activity-oriented decisions. This was also reflected in Chapter 6. There were no patterns in the timing of activity-oriented or goal-oriented decisions that differentiate between the high performing groups and low performing groups.

7.7.3. Time Effort

There were no notable differences between the low performing groups and the high performing groups in the effort spent in each phase. Observations suggested that the management of the process as a whole was crucial to the successful outcome.

Chapter 8

Team Structure and Group Development

8.1. Introduction

Steinfield (2002) suggests that virtual teams have problems with communication and co-ordination. They also have problems with the challenges of working across time and distance. Limited social relations and lack of awareness of what is happening around them can diminish trust among participants. Understanding the composition of high performing teams and low performing teams can aid in determining any characteristics that help to overcome the problems these teams face.

In the search for patterns associated with high performing groups and low performing groups, previous chapters have looked at the communication within the teams (Chapter 5), the decision-making process (Chapter 6) and the software development process (Chapter 7).

A good structure and clear identification of roles is important to the cohesion and advancement of the group. McGrath (1984) states that differentiated roles and patterns of behaviour within group members can lead to the development of expectations for how each team member should behave and what their responsibilities are.

Via a team profile and the individual team member's contribution of communication and decision-making, this chapter looked at the individuals and the experiences, expectations, commitment and goals they each brought to the group. This chapter also investigated the group development process for each team, the structure in terms of each team's interactions and the leadership styles.

8.2. Analyses Design

This research was interested in understanding software development in teams (Chapter 7) and therefore another area that was covered within the design of the research was the concept of group development. It looked at the dynamics of the group, how team members interacted with one another, how they worked, collaborated, communicated learned from each other and made decisions.

The investigation in this chapter used quantitative analysis in the form of a standard deviation test used to look at the decision-making breakdown between individuals in each team. However, most of the investigation in this chapter uses qualitative analyses in the form of observation to identify differences in patterns between the high performing groups and the low performing groups. A profile of each team was compiled from data made available by the Runestone Project academic year 2000.

8.3. Team Profile

Studies found that different factors affect team performance (Psathas, 1960; Goodman, Ravlin and Schminke, 1987; Hartley, 1997). These factors can include team size, experience, attitude, and team and individual goals. As well as looking at the communication in terms of its use, decision-making, and software development, this study also looked at each team's make-up profile.

The strategy and purpose for the creation of the team profiles (Chapter 4) was to allow a comparison of team backgrounds. The team profiles take into consideration

- Personal information
- Previous team working experience
- Computer mediated communication (CMC) experience
- Computer science (CS) experience
- Project expectations

The team profile created was a compilation of excerpts from

- Background questionnaire
- Project work logs
- Journals 1 and 3 (Interval logs 1 and 3)
- Peer evaluation
- Team building exercise

The following sections give the results of each division of the profile compiled for all the high performing groups and the low performing groups.

8.3.1. Team Profile – Personal Information

Table 8.1 - Team Profile: Personal Information

INFORMATION	High Performing Teams 22 students	Low Performing Teams 23 students
Gender	Ratio - M:F – 17:5	Ratio – M:F – 15:8
Age range	Range - 20 - 30 / *Ave – 23.6*	Range - 22 – 48 / *Ave – 26.3*
Team size	2 teams 5 members/2 teams 6 members	1 team 5 members/3 teams 6 members
Team mark (Ave.)	Range - 4.94 – 4.86 TAM / *Ave – 4.88 TAM*	Range - 3.8 – 3.06 TAM / *Ave – 3.52 TAM*
Team total work hours on project	Range - 59hrs 20 min -277hrs 55min / *Ave – 189hrs 10min* / Total - 755hrs 40 min	Range - 84hrs 0min – 347hrs 50min / *Ave – 201hrs 04min* / Total – 802hrs 13min
Team total work hours outside project	Range - 17 - 21hrs / *Ave –19hrs* / Total – 76hrs	Range - 11 – 24hrs / *Ave –19hrs* / Total – 75hrs
Team course load (in number of courses)	Range - 21 - 24 courses / *Ave – 22courses* Total – 88 courses	Range - 13 – 20 courses / *Ave –17 courses* Total – 67 courses
Team communication in percentage – i.e.. Number of emails, IRC etc.	IRC Range - 61% - 88% / *Ave – 81%* Email Range - 12% - 39% / *Ave – 19%*	IRC Range – 64% - 90% / *Ave – 77%* Email Range – 10% - 36% / *Ave – 23%*

Note: the team profile guide is found in Chapter 4. Copies of the questionnaire, journals and logs are found in appendices 4.1-4.3.

Table 8.1 illustrates the personal information for each team gathered from University files, questionnaires, project logs and the emails and IRC communication produced by the teams.

- Gender - The total number of females in the high performing groups and the low performing groups was less than the total number of males. The gender breakdown of males and females showed a higher number of females in the low performing groups.

- Age – The range was wider and average mean age higher in the low performing groups.

- Team Size - All teams were kept between 5-6 members. According to Bennatan (2000)

  the ideal size of a development team is between 4 and 6 developers.

- Team Mark Average- Range was wider in the high performing groups by 0.3 marks. However, the difference between the high performing groups and low performing groups' average mean marks varied by 1.36 marks. Team Mark average mean (TAM) calculation is discussed in Chapter 4.

- Total Hours Worked on Project – The low performing groups had a wider range by 45 hours. They also acknowledged more average mean and total hours than the high performing groups.

- Total Hours Worked Outside of Project - The range of hours worked (in employment) outside the project was wider in the low performing groups. The average mean number of hours worked outside the project was the same for the high performing groups and the low performing groups. The high performing groups had 1 hour more in total outside worked hours than the low performing groups.

- Course Load – The range of courses was wider for the low performing groups. The high performing groups had more average mean courses and more total courses (21 more) than the low performing groups.

- Use of Communication – The range and average mean use of IRC was higher by 1% in the high performing groups. The range of use of email was again higher by 1% in the high performing groups but the average mean email use was higher by 4% in the low performing groups. More information on the use of communication is detailed in Chapter 5.

There were differences in the number of females within the high performing groups and low performing groups. However, the males outnumbered the females in both the high performing groups and the low performing groups. It could be assumed that age was a determining factor in experience but age alone would not determine the amount of relevant experience required to achieve a successful outcome. Experience was therefore examined in the next sections.

The high performing groups acknowledged less working hours on the project, more working hours outside the project and a higher course load. This supported the suggestion identified in Chapter 6 that the high performing groups were more organised and methodical about the work process.

8.3.2. Team Profile - Team Work Experience

Table 8.2 –Team Profile: TeamWork Experience

INFORMATION	High Performing Teams	Low Performing Teams
Team previous experience in team working.	Range -**1**=0, **2**=3-4, **3**=8-15 Total – **1**=0, **2**=15, **3**=46	Range - **1**=0-1, **2**=2-3. **3**=10-15 Total - **1**=1, **2**=11, **3**=51
Team percentage of time working alone	Range - 58% - 87% */ Ave –70%*	Range – 50% - 67% / *Ave –57%*
Team percentage of time working with other(s)	Range – 13% - 42% / *Ave –30%*	Range – 33% - 50% / *Ave –43%*
Team self-classification of roles (Only count of '*4-more than...*')	Ideas - 10 explain – 10 Resolve – 1 askI – 3 AskE - 7 listen – 5 Sum - 7 notes – 0 Lead - 9 do – 7	ideas - 5 explain – 2 resolve – 0 askI – 1 askE - 2 listen – 5 sum - 2 notes – 2 lead - 4 do – 7
Actual team roles	4 off lead/2 lead help / even work load in 3 teams / 1 team 1 non worker	4 off lead / 1 act lead due to lead absence / even work load in 1 team / 3 teams at least 1 non workers
Team opinion about working in teams (% of positive and negative)	Range - Pos 53% - 57% / *Ave – 55%* Range - Neg 43% - 47% / *Ave – 45%*	Range – Pos 46% - 58% / *Ave – 53%* Range – Neg 42% - 54% / *Ave – 47%*
Team goals	Range – 6-10 goals / *Ave –8.5 goals* / Tot – 34 goals	Range – 6 – 8 goals / *Ave –7.3 goals* / Tot – 29 goals
Team initial impressions of team members.	Range - Pos= 2 – 13 counts / *Ave –9 counts* / Tot – 36 counts Range Neg=1 – 5 counts / *Ave –3 counts* / Tot – 12 counts	Range – Pos=5-14 counts / *Ave –8.3 counts* / Tot – 33 counts Range – Neg=1 – 6 counts / *Ave – 3.5 counts* / Tot – 14 counts
Team final impressions of team members.	Range - Pos=1 – 4 counts / *Ave – 2.6 counts* / Tot – 11 counts Range - Neg=1 – 3 counts / *Ave – 1.5 counts* / Tot – 6 counts	Range – Pos=2 – 5 counts / *Ave – 3.3 counts* / Tot – 13 counts Range – Neg=0 – 3 counts / *Ave – 1.5 counts* / Tot – 6 counts
Team characteristics.	Theoret - 0 practical – 6 Intro - 4 extro – 8 Doer - 7 thinker – 8 Method - 7 intuitive – 0 Anal - 16 holist – 0 Calm - 13 excite – 0 Easy - 13 stubborn – 0 Tolerant - 3 avoid – 4 Want - 8 expect – 7 Talk - 8 quiet – 8 End - 8 begin – 3	Theoret - 0 practical – 13 intro - 3 extro – 4 doer - 17 thinker – 0 method - 3 intuitive – 7 anal - 15 holist – 0 calm - 7 excite – 0 easy - 16 stubborn – 0 tolerant – 9 avoid – 3 want - 9 expect – 6 talk - 4 quiet – 7 end - 15 begin –0

Note: the team profile guide is found in Chapter 4. Copies of the questionnaire, journals and logs are found in appendices 4.1-4.3.

Table 8.2 shows the high performing groups and the low performing groups' teamwork experience gathered from questionnaires, peer evaluation, interval logs, emails, and IRC communication produced by the teams.

- Previous Experience in Team Working – Only one person had (1) *never* experienced teamwork. Four more of the high performing students than the low performing students had experienced teamwork (2) *at least once*. More students in total had experienced teamwork (3) *many times* than *never* or *at least once*. The low performing groups had 5 more students who experienced teamwork (3) *many times* more than the high performing groups.

- Percentage of Time Working Alone – The range for the high performing groups was 2% wider than the low performing groups. The average mean percentage of time for the high performing groups was 13% higher.

- Percentage of Time Working with Others – The range for the high performing groups was 12% wider than the low performing groups, however, the average mean for the low performing groups was 13% higher.

- Classification – The question asked *how frequently do you find yourself doing the following activities?* and gave as options *1-never, 2-some but less than other people, 3-about the same as other people and 4-more than other people*. This area of the team profile was interested in looking at those who selected the *4-more than other people* option. The top three classifications for the high performing groups were *initiating ideas*, *explaining* and *leading*. The top three classifications for the low performing groups were *doing the work, initiating ideas* and *listening*. The only classification that they shared in the top three was *initiating ideas*. Both the high performing groups and the low performing groups shared the same amount of *listeners* and *doers* but there were more *note takers* in the low performing groups.

- Actual Team Roles – The roles identified in the class project were that of leader and developer. The leader had the role of co-ordinator and developer. The role of developer included writing code, testing, writing scripts and presenting. All the official leaders for the high performing groups and three of the four low performing groups were also acting leaders throughout the project rather than being absent as in the case of the fourth low performing group. In two of the high performing teams and one low performing team, a developer stepped in to help the leader with co-ordination activities. There was an even breakdown of the developer's workload in 3 of the high performing teams and 1 of the low performing teams.

- Opinion about Working on Teams – The range of positive opinion was wider in the low performing groups with a higher average mean in the high performing groups. The range of negative opinion was wider and the average mean higher in the low performing groups.

- Number of Goals – The range of the number of goals was wider and the average mean was higher for the high performing groups. The total number of goals was also higher by five goals for the high performing groups.

- Initial Impressions of Team Members – The range of positive opinion was wider and the average mean and total were higher in the high performing groups. The range of negative opinion was wider and the average mean and total were higher in the low performing groups.

- Final Impressions of Team Members – The range of positive opinion was the same for both the high performing groups and low performing groups. The average mean and total of positive opinion was higher in the low performing groups. The range, average mean and total of the negative opinion was the same for both the high performing groups and the low performing groups.

- Characteristics – The students were given a choice of two types of characteristics. The high performing groups reported more *extroverts*, *analytical*, *calm*, and an even number of *talkative* and *quiet*. The high performing groups also reported 7 *methodical* students while the low performing groups reported 7 *intuitive* students. The low performing groups reported more *practical*, *easy-going*, *tolerant of risks*, *doing things because you want to* and *enjoy finishing a project more than the beginning.*

Both the high performing groups and the low performing groups had approximately the same amount of teamwork experience. Both had experienced teamwork at least once and many more students had experienced it *many times*.

The high performing groups had a higher average mean percentage of working alone than working with others.

These results and the fact that the high performing groups had more implicit than explicit decisions (Chapter 6) suggest that the high performing students were self-motivated. It is possible that they took from the group meeting what they needed to work on then went on their own to do the work.

The way that the high performing groups and the low performing groups classified themselves was different in the numbers chosen for each classification. However, within the top three classifications both had *initiating ideas*.

The high performing groups classified themselves more as leaders where the low performing groups classified themselves more as *doers*.

The actual roles that each group type adopted was very different. The leaders in both the high performing groups and the low performing groups were active in their roles as leaders and developers. The only exception was in one of the low performing teams. This leader was absent from most meetings and did not fulfil either the role of leader or developer. This was a unique incident where this person felt that

> *I wouled really get this meeting over with now so that I can join the party... I will spend most of my time next week studying for that (other class exam)... but that's the way it is...and I won't let anything else become more important than that exam.*

The contribution of work by the students in the developer's roles was not equal in either of the two groups. This occurred in only one high performing group where the *non-active* person was of oriental background and had difficulties with the English language.

This was more of a problem in the low performing groups where the reasons included again language difficulty, inability to make meetings due to cultural issues (e.g. a female would not be allowed out after a certain time), leaving work to the last minute and not taking the project seriously.

> *I have been busy moving...and that's why I have done almost nothing since last time we met.*
>
> *It is probably just guidelines for people starting up from scratch making sure that they are starting some work...is not really very strict... but arnold said that he wouldn't fail anyone... I am sure he will let us all pass.*
>
> *<K> are you coming into the 1175 lab for the midnight meeting?....<S> i am going to log on from here...at home! i cant come in!...hey....its a parent thing!*

Opinion of working in a team environment differed slightly with the high performing groups having a higher positive average mean. Goals were identified by individuals as:

> *Producing a project that works as well as we can possibly make it work.*
>
> *To learn as much as possible about international group work.*
>
> *Learning more java.*

The high performing groups had a higher average mean and total of goals than the low performing groups. Initial impression of team members taken at the beginning of the project via journal 1, were identified as

I think his ability to contribute to the project is good.

I am not sure of his contributions.

Final impressions taken at the end of the project via journal 3 include

...was supposed to be the team leader but we hardly heard from her.

I think ...probably worked the hardest on the project.

The high performing groups had slightly more positive initial impressions than the low performing groups; however, the low performing groups had more positive final impressions than the high performing groups.

The number of total impressions (both positive and negative) decreased greatly between the initial and final impressions in both the high and low performing groups. As in the self-classification, the characteristics reported by the high performing groups and the low performing groups were also very different.

8.3.3. Team Profile - CMC Experience

Table 8.3 - Team Profile: Computer-Mediated Communication Experience

INFORMATION	High Performing Teams	Low Performing Teams
Team total previous use of CMC	Range – 1=7-17, 2=4-12, 3=5-7 Total - 1=51, 2=31, 3=25	Range - 1=7-18, 2=1-10, 3=3-13 Total - 1=56, 2=18, 3=31
Team total range of familiarity with CMC	Range – 1=9-16, 2=1-5, 3=0-6, 4=1-2, 5=4-7 Total - 1=50, 2=10, 3=17, 4=6, 5=22	Range - 1=4-15, 2=0-6, 3=0-8, 4=1-7, 5=4-10 Total - 1=42, 2=12, 3=13, 4=12, 5=26
Team total opinion on success of CMC work	Range – 6.8 – 10 / *Ave –8.2*	Range – 6.3 - 7.8 / *Ave –7.3*
Team percentage of actual use of artificial media	Range – 20% - 50% / *Ave – 39.5%*	Range – 37% - 57% / *Ave –47.3%*

Note: the team profile guide is found in Chapter 4. Copies of the questionnaire, journals and logs are found in appendices 4.1-4.3.

The group's computer mediated communication (CMC) is illustrated in **Table 8.3**. This information was compiled from questionnaires, interval logs, project logs, emails, and IRC communication produced by the teams.

- Previous CMC Experience – There were more students in both the high performing groups and low performing groups who had *never* used CMC previously than *at least once* or *many times*. More of the high performing students than the low performing students had used CMC *at least once*. Six more of the low performing students had used CMC *many times* than the high performing students.

- Familiarity with CMC – The question asked the students to rate their familiarity with CMC on a scale of 1-unfamiliar to 5-familiar. More of the high performing students were unfamiliar with the use of CMC than familiar. The middle part of the scale (2,3,4) was tipped more toward the unfamiliar side in the high performing groups. More of the low performing groups were also unfamiliar than familiar with the use of CMC. The middle part of the scale (2,3,4) was equally balanced. More of the high performing students stated they were unfamiliar (1) with CMC than the low performing groups and more of the low performing students stated they were familiar (5).

- Opinion on Success of CMC – Students were given the choice to rate the success on a scale of 1-failure to 10-complete success. The range was wider and the average mean of opinion of success was higher in the high performing groups.

- Percentage of Artificial Media Use – Artificial Media was defined as media such as Internet Relay Chat (IRC), Email, Web-Based Discussion Forum, Whiteboard, Videoconference, and Telephone. The range of percentage of artificial media use was wider in the high performing groups with a higher average mean in the low performing groups.

The CMC (computer-mediated communication) experience was approximately the same with more students having never experienced CMC although there were slightly more low performing students than high performing students who experienced CMC *many times*.

This was consistent with the familiarity issue where more students in both group types who were unfamiliar with CMC but again more low performing students than high performing students who had some familiarity of CMC work.

Generally, the high performing groups had a higher opinion of the success of CMC work.

The low performing groups had a higher average mean use of artificial media, which was consistent with the percentage of time spent on group work (section 8.3.2) as group work was done via an artificial medium.

8.3.4. Team Profile: CS Experience

Table 8.4 - Team Profile: Computer Science Experience

INFORMATION	High Performing Teams	Low Performing Teams
Team total CS experience. Known languages	Range – 17 – 23 lang. / *Ave –20 lang.* / Total – 80 lang.	Range – 21 – 25 lang. / *Ave –23 lang.* / Total – 69 lang.
Team total opinion of self-knowledge in CS (Part 1)	Range – **1**=10-20, **2**=18-34, **3**=4-10 Total - **1**=58, **2**=105, **3**=26	Range – **1**=8-23, **2**=22-28, **3**=0-18 Total – **1**=63, **2**=98, **3**=29
Team total opinion of contribution of CS	STD Range – 3.39, 3.39, 3.32, 2.16	STD Range – 5.87, 3.43, 5.71, 6.22

Note: the team profile guide is found in Chapter 4. Copies of the questionnaire, journals and logs are found in appendices 4.1-4.3.

Previous Computer Science experience was gathered from questionnaires, peer evaluation, the team building exercise and emails and IRC communication produced by the teams and detailed in **Table 8.4.**

- <u>Known Computer Programming Languages</u> – The number of known computer programming languages was totalled without counting the same language twice. The range of known languages was wider for the high performing groups with a higher average mean in the low performing groups. The total of known languages was higher in the high performing groups.

- <u>Opinion of Self-Knowledge</u> – The students were asked to express their opinion of their *knowledge compared to standards of your own university* as *1-less than, 2-perfect match* or *3-better than.* More students in both the high performing groups and low performing groups expressed a *perfect match* than any other answer. More of the low performing students than the high performing students stated their opinion of self-knowledge as *less than* and *better than.*

- <u>Opinion of Contribution</u> – Given 100 US dollars and asked to *distribute that money amongst the members of your team*; students in each group distributed the money according to each member's contribution. An average mean of each team member's contribution was taken. A standard deviation (STD) test was then taken of each team's average mean contribution to look at the spread of contribution for the high performing groups and the low performing groups.

```
The formula used is S =√Σd²/N-1
where:
S = Standard Deviation
d² = deviation from mean (average)
N = Number of team members
```

- The standard deviation results for the high performing teams were very similar and range between 2.16 –3.39. The results for the low performing teams had a higher value than the results for the high performing teams and were more spread out. This suggests that the high performing groups had a better distribution of work than the low performing groups.

Computer Science experience in terms of the number of languages known was greater in the high performing groups than the low performing groups.

More students in both group types expressed their opinion of self-knowledge in CS to be a *perfect match* with what is required of the course.

The opinion of contribution to the CS project by the team members also showed that the high performing groups had a better distribution of work than the low performing groups.

8.3.5. Team Profile: Expectations

Table 8.5 - Team Profile: Expectations

INFORMATION	High Performing Teams	Low Performing Teams
Team total personal expectations of hours	Range – 8-21hrs / *Ave –14.3hrs* / Total 57hrs.	Range – 12-18hrs / *Ave –14.3hrs* / Total 57hrs.
Team total expectations of group work	Range – 53% - 64% / *Ave –60%*	Range – 47% - 59% / *Ave –52.3%*
Team total expectations of needed knowledge	Range - **1**=11-24, **2**=11-35, **3**=4-8 / Total - **1**=74, **2**=93, **3**=22	Range – **1**=12-32, **2**=15-28, **3**=0-14 / Total - **1**=81, **2**=85, **3**=23

Note: the team profile guide is found in Chapter 4. Copies of the questionnaire, journals and logs are found in appendices 4.1-4.3.

Table 8.5 shows the groups' expectations of working in a team environment in CS. This information was gathered from questionnaires, and emails and IRC communication produced by the teams.

- Personal Expectations – Students were asked *how many hours per week* they expected to work on the project. The range of expected work hours was wider in the high performing groups and the average mean and total was the same for both the high performing groups and low performing groups.

- Expectations of Group Work – Students were asked *what percentage of your project time...do you think you will spend* working with one other person and working with your group on a regular project week. The range of group work expectation was wider by 1% in the low performing groups. The high performing groups had a higher average mean in the expected group work than the low performing groups.

- Expectation of Needed Knowledge - The students were asked to express their opinion of their *knowledge in the context of what you need to complete this project* as *1-less than, 2-perfect match* or *3-better than.* More students in both the high performing groups and the low performing groups expressed a *perfect match* than any other answer. More of the low performing students than the high performing students stated their opinion of self-knowledge as *less than* and *better than.*

The number of average mean and total expected hours was the same for both the high performing groups and the low performing groups.

The total number of actual work hours per week for the high performing groups was 84 hours (756 total hrs/9wks) and for the low performing groups was 89 hours (802 total hrs/9wks).

The number of expected hours per week was much less for both group types than the actual project hours worked.

The average mean percentage of expected group work was higher in the high performing groups and again higher for both group types than the actual percentage of time working in teams.

The expectation of needed knowledge was expressed by most of the high performing groups and low performing groups as a *perfect match* to the knowledge they had. This was consistent with the self-knowledge of CS they expressed in section 8.3.4.

8.4. Group Development Process

Research into the different group development models found Poole's (1981) model appropriate for this research. It incorporates the basic elements of Tuckman's (1965) unitary model; however, Poole (1981) believes that groups do not follow the same sequence of phases but that different groups follow different sequences. This implies that groups take different paths, depending on the ensemble of conditions at a given point in the problem-solving process. The flexibility of movement in Poole's multiple sequence group development model complements the iteration in the Waterfall software development model.

In order to study the idea of multiple sequences, Poole derived a set of basic activity patterns from phasic descriptions that reflected previous findings. He outlined the functions performed by the group in each pattern but did not imply any particular order. The patterns and brief descriptions are outlined in **Figure 8.1**. The diagram in **Figure 8.1** has been represented to show the movement between patterns. It is important to note that these patterns have no particular order or sequencing.

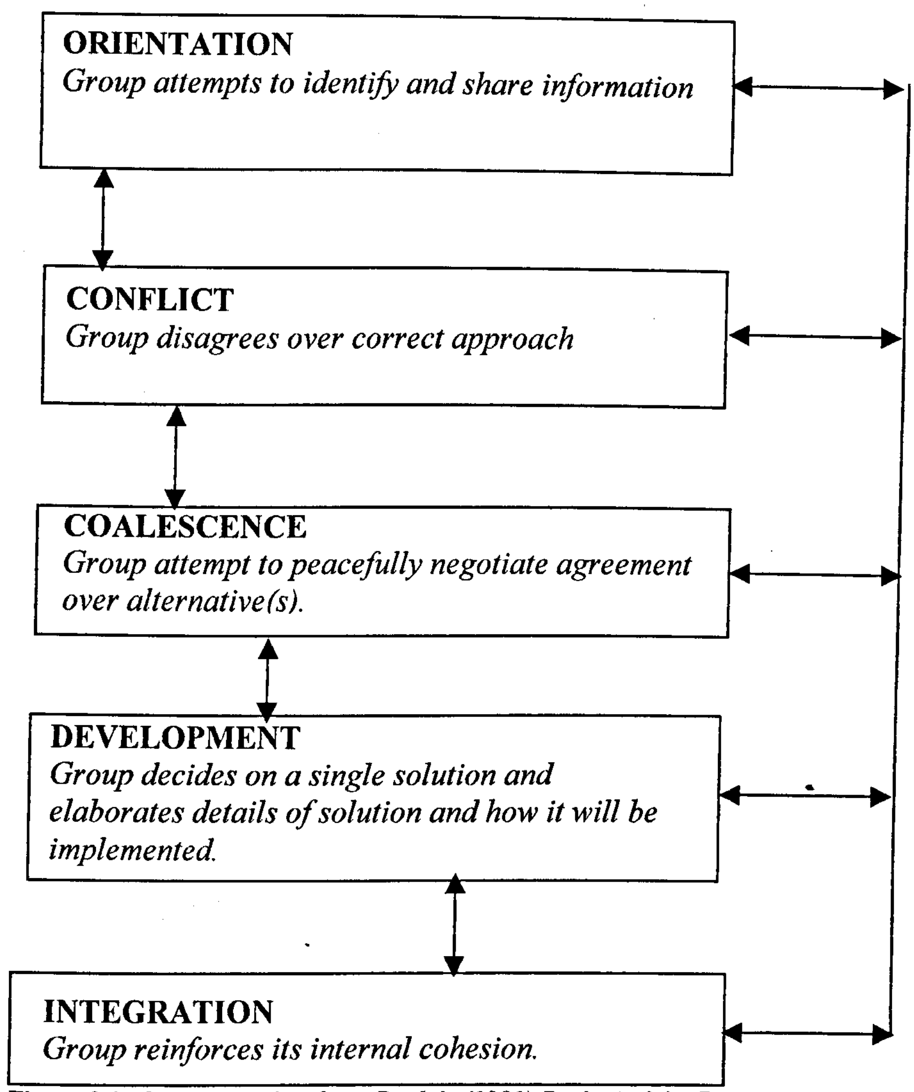


Figure 8.1 - Representation from Poole's (1981) Basic Activity Pattern

This research used the phases outlined in Poole's model to study the group development process in the teams. Using the definition given in Poole's model for each phase and data driven analysis, the team's communication was analysed and the group development phases were identified according to what was happening during each of the communications. A summary log was developed which consisted of the type of communication, the date of the communication, the group development phase (as per Poole's definition) and a summary of the communication. The data from this summary log was used to create charts (**Figure 8.2, Figure 8.3**) and tables (**Table 8.6**) for use in analyses. Because of spatial limitations, the summary log is not included in this thesis but can be made available. The following sections show the results of observation-based qualitative analysis carried out on each team's group development phases.

8.4.1. Group Communication Related to Group Development

Previous analyses (Chapter 5 and Chapter 6) found that there were differences in the amount of communication and decisions made between the high performing groups and the low performing groups. This analysis looked for differences between the high performing groups and the low performing groups in the percentage of each group development phase. The question for this observation is

Question

Q - were there differences between the high performing groups and the low performing groups in the percentage of each group development phases?

Chapter 5 showed that the teams all had different amounts of communication. In order to make a fair comparison of the groups' development phases; a percentage was calculated from the amount of communication related to each phase against the total amount of communication in all of phases. When plotting each team's percentage of group development phases, the overall trend of the patterns was very similar as shown in **Figure 8.2**. The data used to create the following chart is discussed in section 8.4.

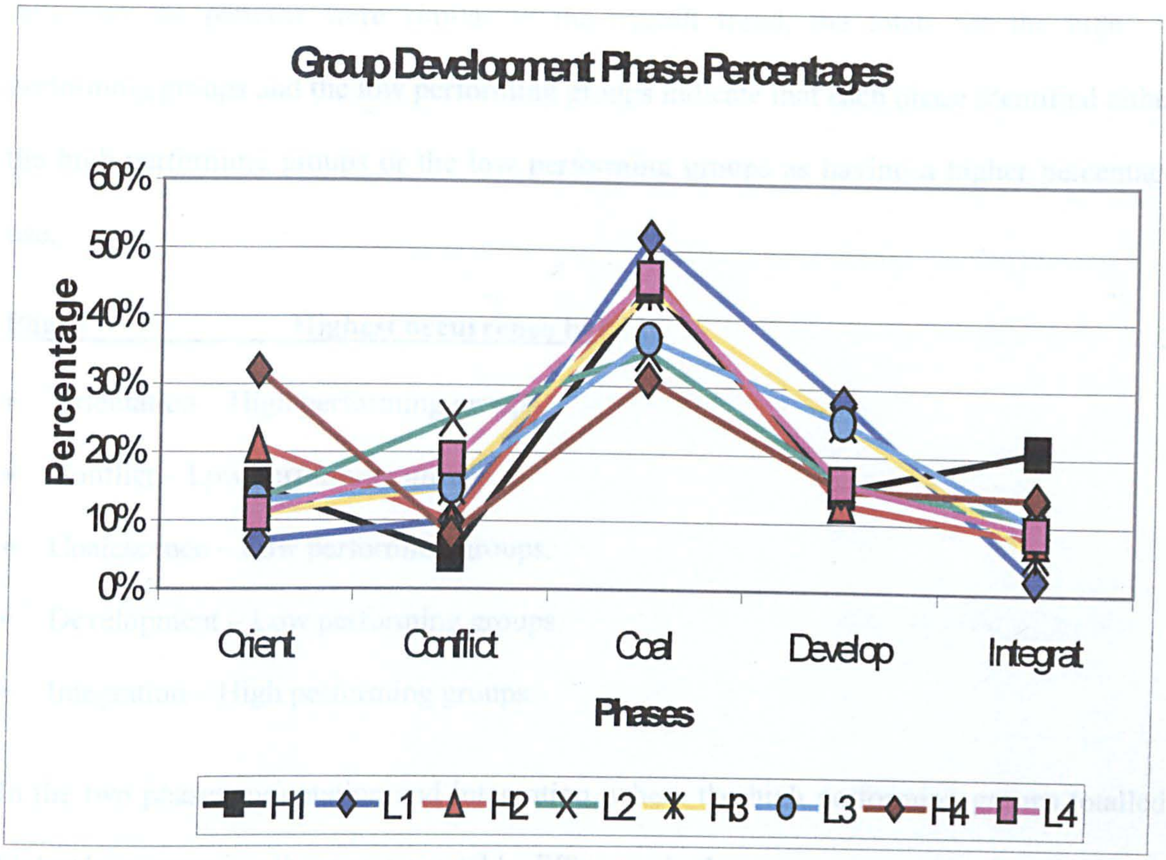


Figure 8.2 - Group Development Phase Percentages

Table 8.6 - High and Low Group Totals of Group Development Phases

	Orientation	Conflict	Coalescence	Development	Integration
High Group Total	**142**	66	298	123	**92**
High Group Avg mean	35.5	16.5	74.5	30.75	23
Low Group Total	88	**150**	**311**	**148**	72
Low Group Avg mean	22	37.5	77.75	37	18

Table 8.6 above shows the totals and average means for the high performing groups and the low performing groups. The data used to create the table is discussed in section 8.4.

All teams except one high performing team had coalescence as the highest occurring phase.

Conflict had the second highest occurrence with development being a close third.

Although the patterns were similar in the overall trend, the totals for the high performing groups and the low performing groups indicate that each phase identified either the high performing groups or the low performing groups as having a higher percentage use.

<u>Phase Highest occurrence by:</u>

- Orientation – High performing groups.
- Conflict – Low performing groups.
- Coalescence – Low performing groups.
- Development – Low performing groups.
- Integration – High performing groups.

In the two phases, orientation and integration, where the high performing groups totalled higher in occurrence; there was a notable difference in the average means.

In the three phases where the low performing groups had a higher total of occurrences, the differences in the average mean of two phases (coalescence and development) was minor. However, the difference in the average mean and total of the third phase (conflict) was more noticeable.

Result

This suggested that in negotiating and making decisions, the two types of groups (high and low performing) were similar. However, in identification, sharing information and reinforcing their internal cohesion, the high performing groups were slightly better. This was reinforced by the fact that the low performing groups had more conflict than the high performing groups.

8.4.2. Group Development Phase Throughout Time

Further investigation looked at the teams' percentage of communication within each group's development phase across the 9-week project duration as shown in **Figure 8.3** below. Using periods as in previous analyses would not have shown the development of each group. The 9-week duration was used in order to track the development for each group on a weekly basis. The question for this observation is.

Question

Q - were there differences in the patterns of use between the high performing groups and the low performing groups throughout the project's timeline?

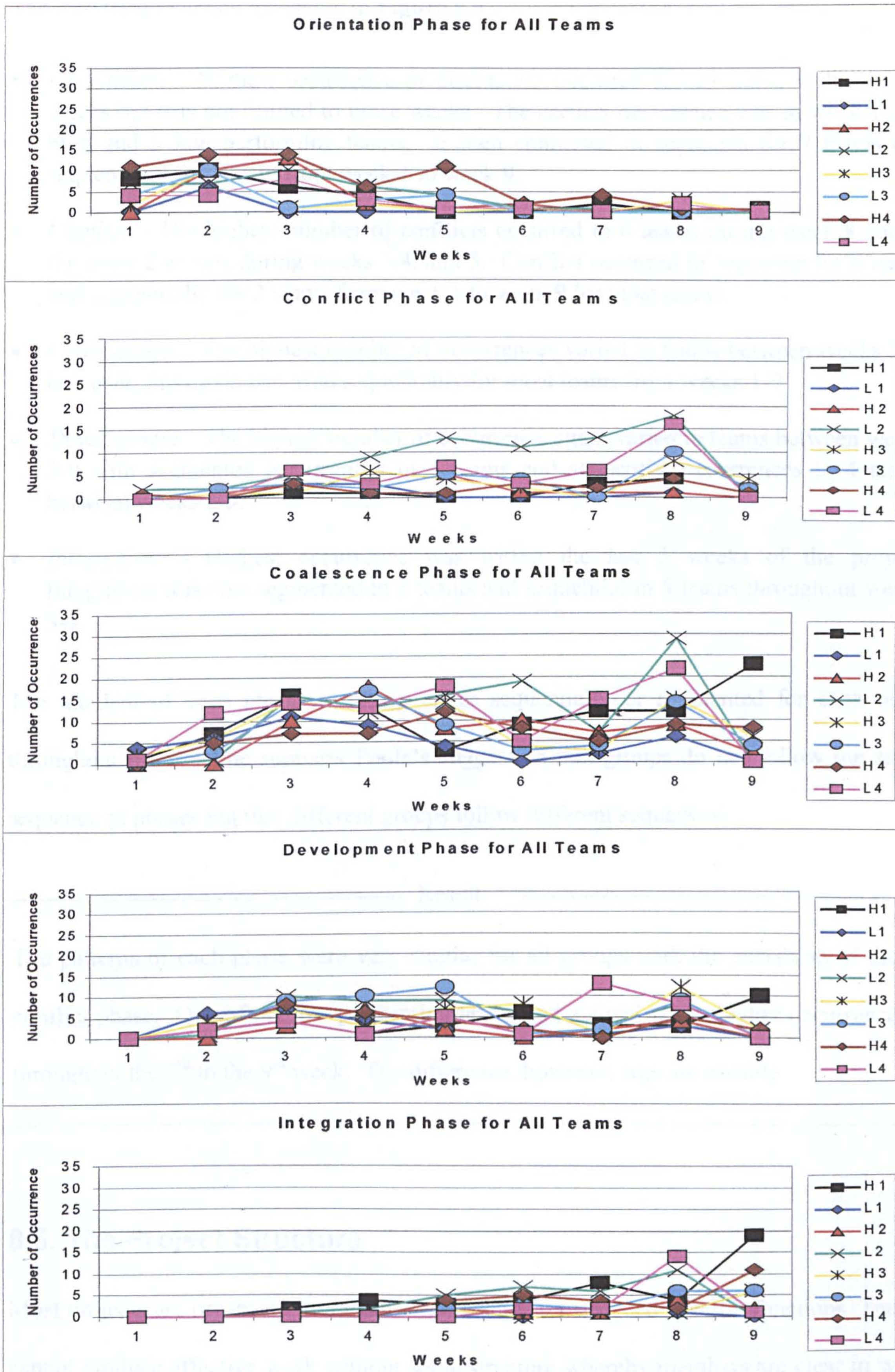


Figure 8.3 - Group Development Phase Thoughout Time

The data used to create the charts in **Figure 8.3** iscussed in section 8.4.

- *Orientation* – Highest occurrence of orientation occurred for all teams in the first 3 weeks but was not limited to those weeks. The earliest occurrence was in week 1 in 3 high and 3 low performing teams. It then continued in segments for 7 teams and sequentially for 1 team from week 1 to week 9.
- *Conflict* – The highest number of conflicts occurred in 6 teams during week 8 and in the other 2 groups during weeks 3,4, and 5. Conflict occurred in segments for 6 teams and sequentially for 2 teams from week 1 to week 9 for most teams.
- *Coalescence* – The highest number of occurrences varied in teams between weeks 3-9, however, this again occurred sequentially for most teams from weeks 1-9.
- *Development* – The highest number of occurrence again varied in teams between weeks 3-9 with segmented occurrences in 4 teams and sequential occurrences in 4 teams between weeks 2-9.
- *Integration* – Highest occurrence was within the last 3 weeks of the project. Integration was also segmented in 3 teams and sequential in 5 teams throughout weeks 3-9.

The incident of each phase occurring either sequentially or segmented for each team throughout the timeline supports Poole's suggestion that groups do not follow the same sequence of phases but that different groups follow different sequences.

Result

The patterns of each phase were very similar for all groups with the exception of the conflict phase. One of the low performing teams had a consistently higher occurrence throughout the 5th to the 9th week. The difference, however, was not notable.

8.5. The Project Structure

Most projects are organised into teams with each team assigned specific functions. Teams cannot produce effective work without some structure whereby members are clear in what they are supposed to do. Different types of projects require different types of structures (Bennatan, 2000). In the Runestone project, the project structure was set by the structure of the classes whereby the tutors were the project managers and the students had the role of team leaders and developers.

The teacher in each country took responsibility over half of the teams. Each team included students from both countries. All the team members took on the role of developers, and each team assigned a team leader. The project structure is identified in **Figure 8.4** below.

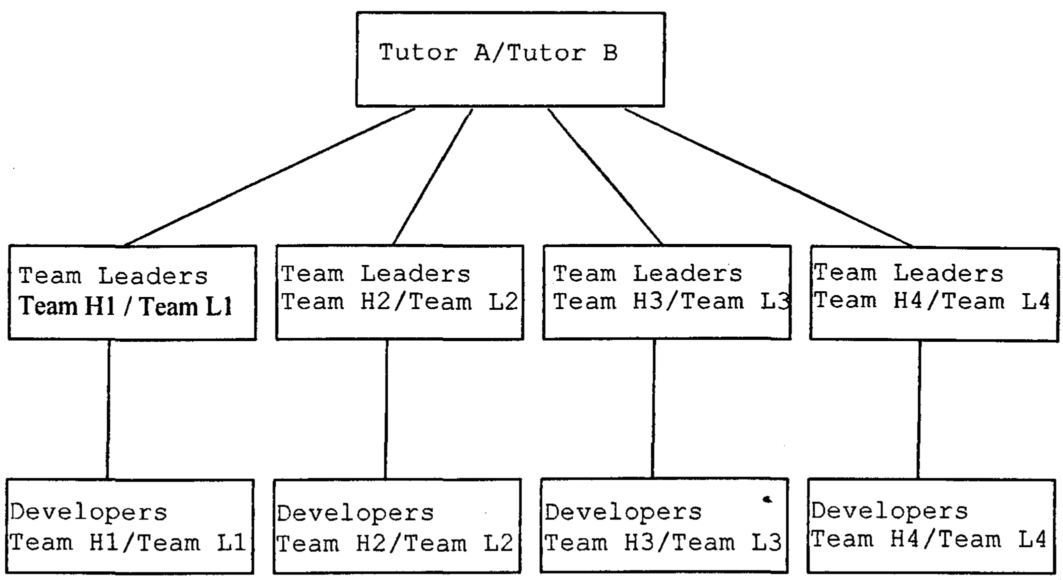


Figure 8.4 - Project Structure

Once identified, the project structure should not change regardless of any team's strategies. Other issues such as the communication structure, leadership styles, decision patterns and role identification can vary or change depending on the actions and strategies adopted by the teams.

Bikson and Eveland (1990) suggests that a team's structure can change when groups communicate through computers instead of the traditional face to face means. The following sections look at the communication structures, leadership styles, role identification and decision patterns for each team.

8.5.1. Communication Networks

Grounding is the process by which multiple participants maintain some degree of mutual understanding (Baker, *et al*, 1999). This mutual understanding is maintained via communication and interaction between the team members. Group communication and interaction has been a research interest for several decades. The result of this research has generated different communication networks (Bavelas, 1948; Leavitt, 1951; Mills, 1967; Scott and Simmons, 1975; Mantei, 1981; McGrath, 1984; Brown, 1985; Hartley, 1997) as per **Figure 8.5** below.

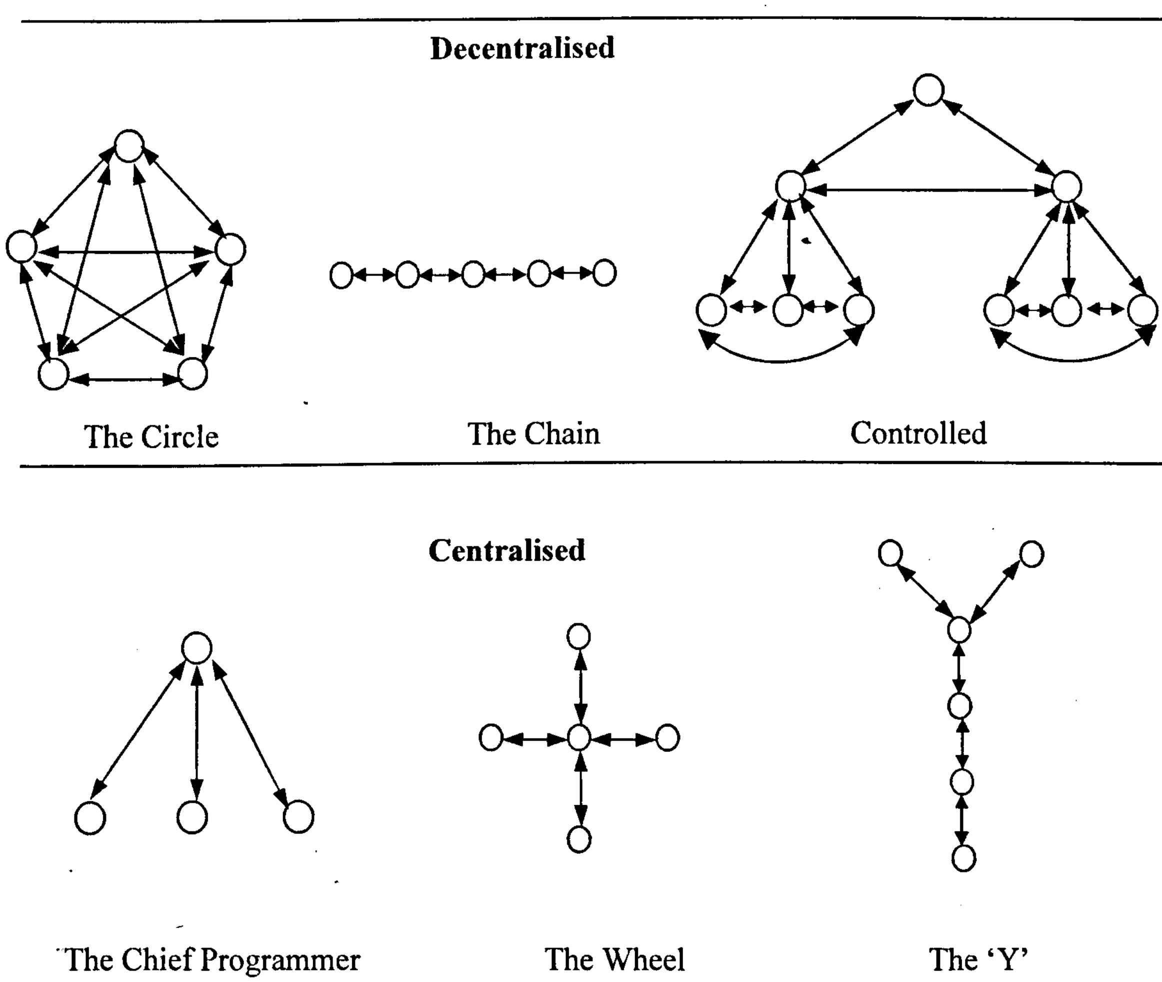


Figure 8.5 - Communication Networks

The communication networks are classified as either **centralised** or **decentralised**. **Decentralised** communication links are open communication channels and allow the dissemination of information to all participants. **Centralised** communication links are more directed and centralise communication around the person in authority.

Research into the different types of communication networks showed that speed, accuracy and efficiency were greater on simple tasks in the centralised networks when the member at the centre is able to effectively pull information together. On complex tasks, decentralised networks were more efficient as it was seen that the central member in a centralised network could be overloaded (Mills, 1967; Mantei, 1981; Hartley, 1997).

Mantei (1981) suggests that an example of a **simple task** is one that deals with report generation or payroll programming. Using these examples as definition of a **simple task** as a guideline, the task given to the students in the Runestone project is considered a difficult task, which involves a great deal of programming, by a group of novice students.

Observation

According to research findings mentioned above, the more appropriate communication network for the teams in Runestone Project should be one of the decentralised networks.

The students in the Runestone Project were given a choice of communication technology to use. However, the only requirement they had was that they needed to meet as a team with each other and with their tutor at least once a week. They were not required to use any particular media or to communicate in any particular way, however as the teams were distributed, they would need to communicate electronically. The technology most used by all the teams was Email and IRC (Internet Relay Chat). Communication network models were developed for each team (**Figure 8.6**) via the use of data driven analysis carried out on the communication produced by the teams.

Emails were sent to every member in the group as all groups were given aliases. There were occasions when one person was singled out to do something or to reply to a question. This research looked to see if each email that asked for a reply was replied to. In IRC communication, again most of the conversation was directed at the group but on occasions, one individual was singled out. Investigation again checked to see if all questions were replied to. As well, all IRC and email communication was examined for correspondence to and from every individual in the group.

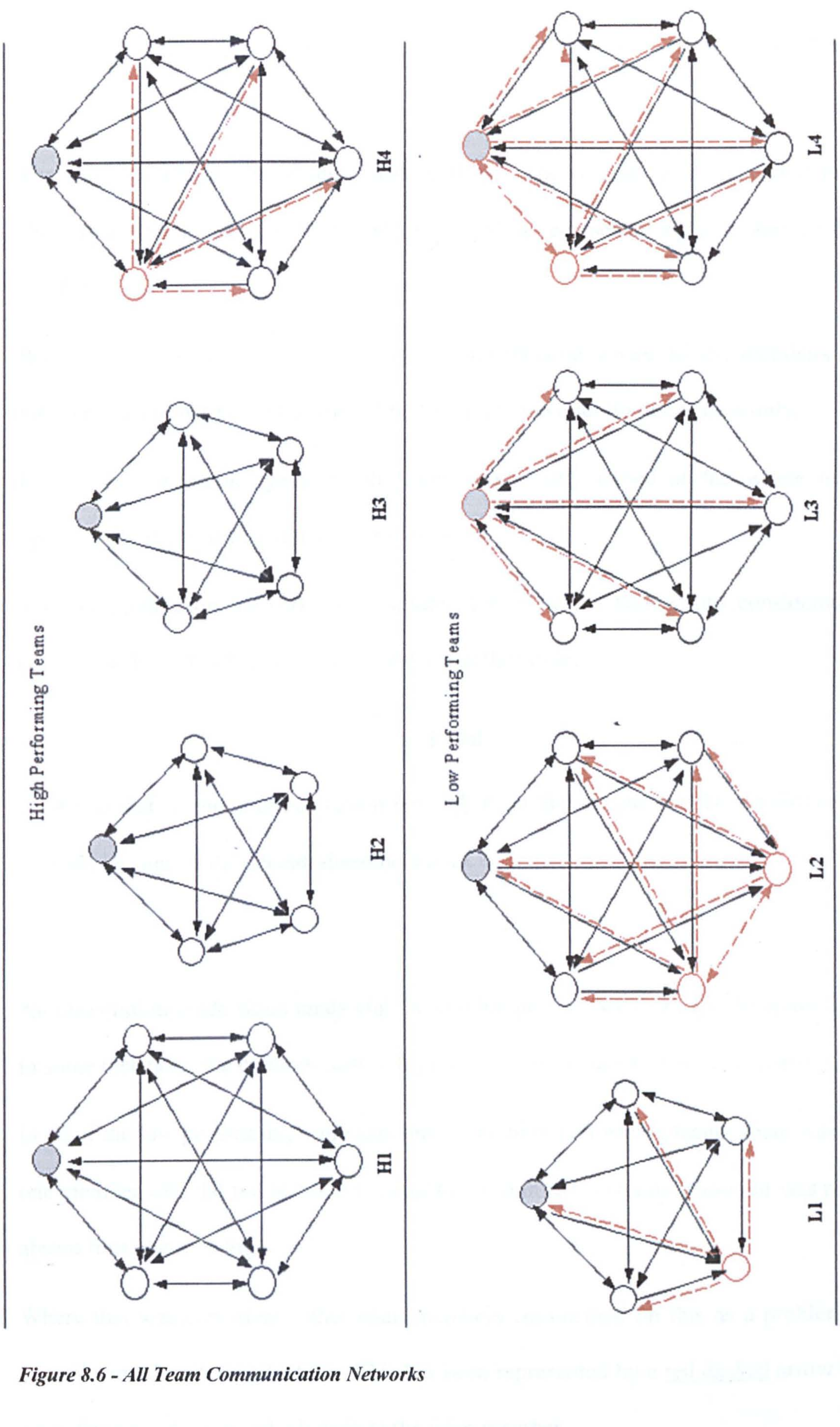


Figure 8.6 - All Team Communication Networks

In **Figure 8.6**, each circle represents a team member with the team leader shaded in grey.

The arrows represent the communication flow. The original communication networks show that communication flows both ways and is represented by a double arrow solid black line.

IRC communication by all teams was a group meeting where all the members present *talked* to each other rather than directing the communication to one person only.

Email communication again by all teams was mostly aimed at the whole team but occasionally it was directed to one or two people.

The communication network most suitable for all teams taking into consideration the communication flow between all members was the circle.

Result

As predicted, the communication network most appropriate for the Runestone project task was one of the decentralised networks.

An observation made when analysing the communication networks for the teams was that in some instances, the communication from one or two members was very sparse.

In all of the low performing teams and one of the high performing teams, there was at least one member who did not respond to emails or join in IRC communication or was regularly absent from the meetings.

Where this was consistent, other team members commented on this as a problem in the journals and the peer evaluation. This has been represented by a red dashed arrow leading away from a red circle, which depicts the team member.

The <u>*red member*</u> in team H4 and the <u>*non-leader red member*</u> in team L4, had the communication problem because they were of oriental origin and did not speak good English or Swedish.

The difference between these two teams was that in team H4, this was recognised early on and the team leader took on the responsibility of communicating and working with her to ensure a link. Although she had very little communication with the rest of the teams, she did have a solid link with the team leader.

In team L4, the *red member* was left on her own.

Result

All the teams had the same type of communication network or structure, however, the links and therefore the information exchange for the high performing groups had more solid links than that of the low performing groups. Teams H1, H2 and H3 all had solid communication links going both ways. Teams H4, L1, L2, L3 and L4 all had at least one team member who did not have a solid link with the rest of the team. The difference between H4 and the rest of the teams is that in H4, the team leader took responsibility of keeping a solid communication with that team member.

8.5.2. Leadership Style

As with the communication networks, there has been a great deal of research done on the role of the leader. Researchers have identified different functions associated with being a leader, however, there is no recipe for good leadership. In identifying leader types, researchers have identified the types of teams such as *democratic* where the leader takes on the role of co-ordinator or *chief engineer* where the leader is more in control. (Mantei, 1981; Bennatan, 2000). Belbin (1996) identifies leaders as either a **solo leader** or a **team**

leader but states that the **team leaders** will probably be more successful than the **solo leader**.

Solo Leader	Team Leader
Plays unlimited role (interferes)	Chooses to limit role (delegate)
Strives for conformity	Builds on diversity
Collects acolytes	Seeks talent
Directs subordinates	Develops colleagues
Projects objectives	Creates Mission

As Belbin suggests that the **team leaders** will be more successful, the question for this observation is.

Question

Q - were there more **team leaders** in the high performing teams than in the low performing teams?

The process of choosing a team leader was left to the teams. The team leaders were either self volunteered or suggested by other members for the job and a vote was then taken. In some teams, but not all, there was some discussion about why a particular member would be suitable for the job.

The leader types were identified in this study using Belbin's identification of solo leader and team leader. This research investigated the leader's relationship with the team members using all the communication logs. The communication logs were read again and each team leader was investigated in terms of the following definitions as per Belbin (1996).

Solo Leader

1. Plays unlimited role – the solo leader interferes in everything.
2. Strives for conformity – the solo leader tries to mould people to particular standards.
3. Collects acolytes – the solo leader collects admirers and sycophants.
4. Directs subordinates – subordinates take their leads and cues from the solo leader.
5. Projects objectives – the solo leader makes it plain what everyone is expected to do.

Team Leader

1. Chooses to limit role to preferred team roles – delegates roles to others.
2. Builds on diversity – the team leader values differences between people.
3. Seeks talent – the team leader is not threatened by people with special abilities.
4. Develops colleagues – the team leader encourages the growth of personal strengths.
5. Creates mission – the team leader projects the vision which offers can act on as they see fit.

If a leader had more of the solo leader characteristics and less of the team leader characteristics as per the definitions above, then he/she would be classified as a solo leader.

If a leader had more of the team leader characteristics and less of the solo leader characteristics as per the definitions above, then he/she would be classified as a team leader.

If a leader had an equal amount of each type of characteristic, other methods such as investigation of the decision-making methods would also have been considered. However, for this study, this was not necessary, as the distinction of characteristics was clear for the leaders.

The result of this analysis is summarised in **Table 8.7** below.

Table 8.7 - Team Leader Summary

Team	Choice	Justification	Leader Type	Decision-Making Methods
		High Performing Teams		
H1	Suggested	Because he knows both Swedes and Americans	Team Leader	3,4,6,7
H2	Volunteer	Swedes did not want the job.	Team Leader	3,6,7
H3	Volunteer	Based on ability to be organised	Team Leader	1,3,4,5,7
H4	Volunteer	Wants to do the job.	Team Leader	1,3,7
		Low Performing Teams		
L1	Volunteer	Wants to do the job.	Team Leader	3 and 6
L2	Volunteer	Wants to do the job	Solo Leader	1, 3,4,5,6,7
L3	Volunteer	Wants to do the job. Has some opposition but is ignored	Solo Leader	2,3,5,6,7
L4	Suggested	Is voted in while she is not present at meeting.	Solo Leader	1,3,4,6,7

Column 2 gives the choice of whether the person was *suggested* by other team members or *self volunteered.*

Column 3 states the reason given for the suggestion or volunteering.

Column 4 states the type of leader they were according to Belbin's leader type.

Column 5 outlines the decision-making methods used by the leader in each group. The methods are outlined below. More on decision-making can be found in Chapter 6.

Methods	Used by number of teams: High	Low
• 1 – Decision by authority without discussion	2	0
• 2 – Decision by authority after discussion	0	1
• 3 – Decision by expert member	4	4
• 4 – Average members' opinion	2	2
• 5 – Majority control	1	2
• 6 – Minority control	2	4

- 7 – Consensus 4 3

The outline above shows the decision-making methods as described by Hartley and the number of teams in the high performing groups and the low performing groups which used a particular method. The most used method for decision-making by all the team leaders was method 3 (*decision by expert*) with method 7 (*consensus*) being the second most used. All other methods were evenly used by the low performing groups and high performing groups.

Most of the leaders volunteered to be leaders rather than being suggested as team leaders.

The justification for 3 of the low performing teams as to the choice of leader was because *they wanted the job* whereas 3 of the high performing teams looked at other issues besides *wanting the job.*

Result

All of the leaders for the high performing groups were **team leader** types, however, three of the low performing teams had **solo leader** type.

This was consistent with the team profile where the high performing groups classified themselves more as leaders and the low performing groups classified themselves more as *doers.*

8.6. Individual Members

Teams or groups are made up of individual people who bring into the group different experiences, backgrounds and goals. Interaction among group members is both inevitable and necessary. Individual members will have some sort of relationship with other member(s). The way group members interact with each other can have positive and negative influences on how the group functions (Mills, 1967; Hartley, 1997). Steinfield (2002) suggests that virtual teams have problems with communication and co-ordination. They also have problems with the challenges of working across time and distance. Limited social relations and lack of awareness can diminish trust among participants.

8.6.1. Individual or Team Goals

Weldon and Weingart (1993) and Mills (1967) distinguish between group goals and individual goals. Working as part of a group, each individual member can have an individual goal which may be the same or different from the group goal. Thelen (1968) perceives work done by groups as an activity where the members are seen as *pulling together* and there is a feeling of co-operation. In order to achieve this, goals must be publicly stated and shared. Goals are seen as important guides of human actions. People who are goal-directed tend to direct their behaviour towards attaining the specified goal while ignoring activities that are not relevant to the goal. This leads to the belief that there is a correlation between goal commitment and performance.

Investigation of the individual team members' communication and questionnaires showed a mix of both individual goals and group goals as Weldon and Weingart (1993) and Mills (1967) suggest. Individual goals include:

Make contacts in the US and get good experience for future job applications.

Experience project work with other nationalities.

To graduate.

Group goals include:

Managing the group towards ONE goal.

Doing my best and hopefully help my team to be the best team. Motivate everyone in the team to do there best for the project.

Not letting my group down and make sure the project gets well done.

Thelen's (1968) perception of groups *pulling together* to work on an activity was reflected in this research by the commitment shown in attending the meetings and communicating with other team members in order to achieve the goals. Missing a meeting due to illness or another unforeseen commitment was seldom, although it did occur in most teams.

> *I have class during the this meeting at 17:15. Sorry. I'll get the info from P. H3-E76.*

> *<E>J...how are your them titanium screws treating ya?...<J>I was rather dizzy yesterday. Slept all afternoon and night. H1-I40.*

Missing meetings due to forgetfulness or for unexplained reasons was more common in the low performing teams.

> *<P>I meant...CNNOT DO TUESDAYS...<K>...you can too do it Tuesdays from 3:00pm to 4:00pm when we have class...<P> I have the same class at :304 PM 4:30 PM but this time is not in the lab!...<K> this is rediculous, she can too do Tuesdays, that is why Carl cancelled class to give us more time...she would NORMALLY be in class then...<P>Tuesdays, I canot make it. L2-I25.*

> *<M>I kind of wish H and J were here so we could all discuss what needs to be done and who is going to do what...<E>they haven't been here today?...<M>no they haven't...<E>H said she didn't had any time to spend on this project this week.L4-I9.*

8.6.2. Most Frequent Communicator

As stated in the previous section, this analysis investigated the suggestion that there was a correlation between goal commitment and performance. An individual's commitment to the goal was measured by their attendance and participation, which was reflected in the amount of communication. A question for this observation is.

Question

Q - did the individual with the most amount of communication also have the highest grade?

Further investigation looked into the amount of communication by the individual team members, their role within the group (i.e. leader) and their final individual grade. A count of the communication frequencies was done for each individual in each team. A percentage was then calculated for each individual over the team communication frequency total. This was compared with other team members, their role within the team (i.e. leader) and their final grade. The results are seen in **Table 8.8** below.

Table 8.8 - Top Three Highest Communicators

HIGH PERFORMING TEAMS – Top 3 Communicators				
TEAM H1	Grade position in group	Position from highest grade	% of total communication	% Range of others in group
1	1st-Highest	Highest	36.30%	11.1% - 6.0%
2 (Lead)	Joint 2nd (with 4th comm)	1/2 pt down	18.90%	
3	3rd	2 pt down	18.00%	
TEAM H2				
1	Joint 2nd (with 5th comm)	1pt down	24.50%	16.1% - 14.3%
2 (Lead)	Joint 1st (with 4th comm)	Highest	21.00%	
3	3rd - Lowest	1 1/2 pt down	17.80%	
TEAM H3				
1	1st-Highest	Highest	31.40%	11.0% - 4.5%
2	3rd – Lowest	1 1/2 pt down	24.00%	
3 (Lead)	Joint 2nd (with 4th and 5th comm)	1/2 pt down	21.60%	
TEAM H4				
1 (Lead)	Joint 3rd (with 5th comm)	1pt down	26.90%	10.1% - 3.6%
2	1st –Highest	Highest	26.80%	
3	2nd	1/2 pt down	23.70%	
LOW PERFORMING TEAMS – Top 3 Communicators				
TEAM L1	Grade position in group	Position from highest grade	% of total communication	% Range of others in group
1 (Lead)	1st – Highest	Highest	38.40%	12.1% - 8.3%
2	2nd	1/2 pt down	22.50%	
3	3rd	1 pt down	14.80%	
TEAM L2				
1 (Lead)	Joint 1st (with 2nd and 3rd comm)	Highest	33.60%	7.9% - 7.2%
2	Joint 1st (with 1st and 3rd comm)	Highest	28.30%	
3	Joint 1st (jwith 1st and 2nd comm)	Highest	14.10%	
TEAM L3				
1 (Lead)	1st – Highest	Highest	24.40%	13.4% - 8.3%
2	2nd	1 pt down	21.20%	
3	Joint 3rd (with 4th and 5th comm)	2 pt down	18.10%	
TEAM L4				
1	2nd	1/2 pt down	28.90%	12.0% - 2.7%
2	Joint 4th – Lowest (with 5th comm)	2 pt down	26.40%	
3	1st – Highest	Highest	23.20%	

Table 8.8 shows the top 3 communicators (in terms of frequency percentages) for the high-performing teams and the low-performing teams.

The first column on the left identifies the team, the 1st, 2nd and 3rd communicators and the position of the leader within the three top communicators.

The second column entitled *Grade position in group* specifies the position of the individual's final grade given within the group.

The third column *Position from highest grade* serves two purposes. First is to maintain the anonymity of the team members by not specifying grades, and second it shows the steps or points of the grades from the highest given grade within the group.

As mentioned in Chapter 2, each student was given a final individual grade calculated by taking into account milestone grades, functionality of the project, presentation of the project, peer and teacher evaluation and participation in the Runestone Project. The final grade given was in the form of A+, A, A-, B+, B, B-, C+, C, C-, D+, D, D-, U.

For **Table 8.8**'s purpose of showing the position of the grade from the highest grade given, ½ pt was considered between each grade. For example, if the highest grade was A+ the position from the highest grade to a B+ was 1-½ points down. There was ½ pt between A+ and A. Another ½ pt between A and A- and yet another ½ pt between A- and B+.

The fourth column is as explained earlier where a percentage was calculated for each individual over the entire team communication.

The fifth column gives the range in percentages of the other (not top 3) communicators in the team.

There were several interesting observations in **Table 8.8** that are outlined below.

- The team leader was in the top 3 highest communicators for each team in 7 out of 8 teams.
- The highest grade was always in the top 3 communicators.
- There were 8 positions where a joint grade position existed. Six out of 8 positions were within the high-performing teams.
- The highest communicator also received the highest grade in 5 out of 8 teams.

- The largest difference in point position from the highest grade was 2pts but this only occurred three times. The mode of the point difference was ½ pt indicating that there wasn't too much difference between the grades.

The main difference between the high performing groups and low-performing groups was that in the low-performing groups, the leader was also the highest communicator except for one team where the leader was one of the lowest communicators.

In the high-performing groups, the leader was in the top 3 communicators but was the highest communicator in only one team. These show that there was a much wider spread of communication among all team members (and possibly work), within the high-performing groups.

8.6.3. Comparison of Communication and Grade Ranking

A comparison of the grade ranking, i.e. 1st, 2nd, 3rd, … in the group, and the ranking of the amount of communication, showed that in all teams there was a decline in communication percentage from the 1st grade ranking down to the 6th grade ranking (**Figure 8.7**). There was no team where the lower grade ranking members had a higher communication percentage than the higher grade ranking members.

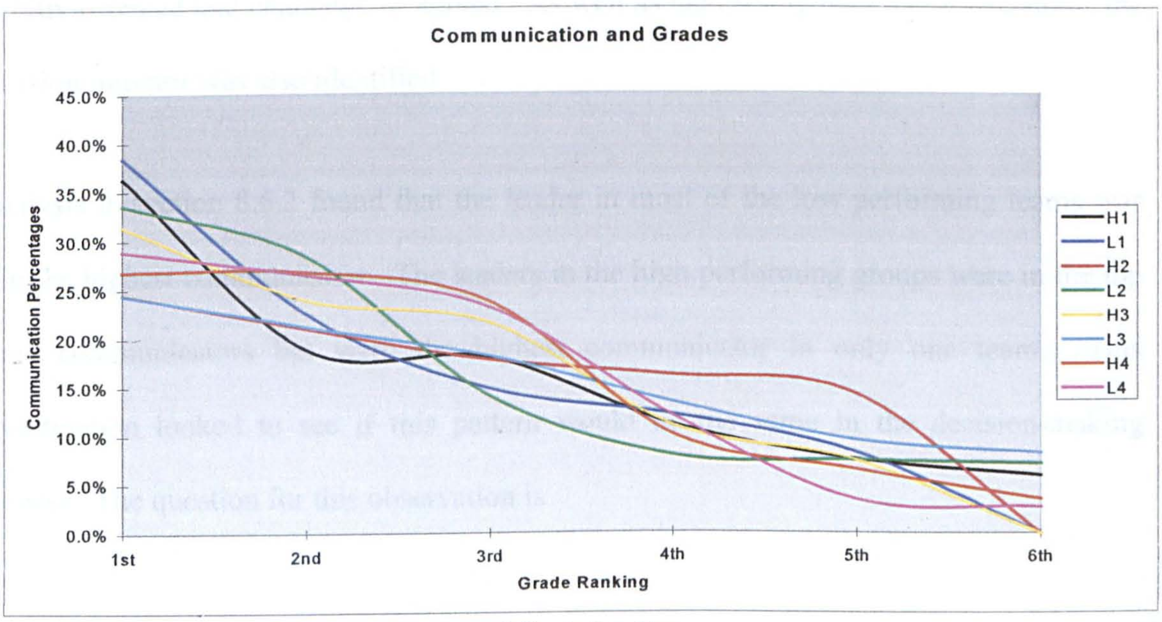


Figure 8.7 - Comparison of Communication and Grade Ranking

Result

The individual with the most amount of communication also had the highest grade in 5 teams. The individuals with the highest grade were always in the top three highest communicators.

This could contradict DeSanctis, *et al's,* (2001) suggestion that the high performing teams do not necessarily communicate more. It could be argued, however, that within the team's communication, regardless of the total team quantity, the amount of communication by an individual can reflect the measure of work or commitment the individual has put into the project. Taking DeSanctis, *et al*'s suggestion one-step further, the amount of communication per team can reflect the team's focus or lack of focus. The amount of communication by an individual within the team then reflects the individual's contribution.

8.6.4. Comparison of Decision-Making and Grade Ranking

As discussed in Chapter 6, decisions were identified as implicit or explicit, goal-oriented or activity-oriented and challenge or agreed. As well as identifying the type of decisions, the decision initiator was also identified.

Analysis in section 8.6.2 found that the leader in most of the low performing teams was also the highest communicator. The leaders in the high performing groups were in the top three communicators but were the highest communicator in only one team. This investigation looked to see if this pattern would be the same in the decision-making process. The question for this observation is

Question

Q - did the leaders in the high performing groups have a different pattern in decision-making than the leaders in the low performing groups?

In order to look further into the type of communication by an individual member, a comparison of the grade ranking and decision-making was made. **Figure 8.8** (high performing groups) and **Figure 8.9** (low performing groups) show the decision-making patterns for each team's members across the 9-week project period. The individual team members in each team are identified in the legend in descending order from the highest grade at the top to the lowest grade at the bottom. The team leaders have a (L) next to their initials.

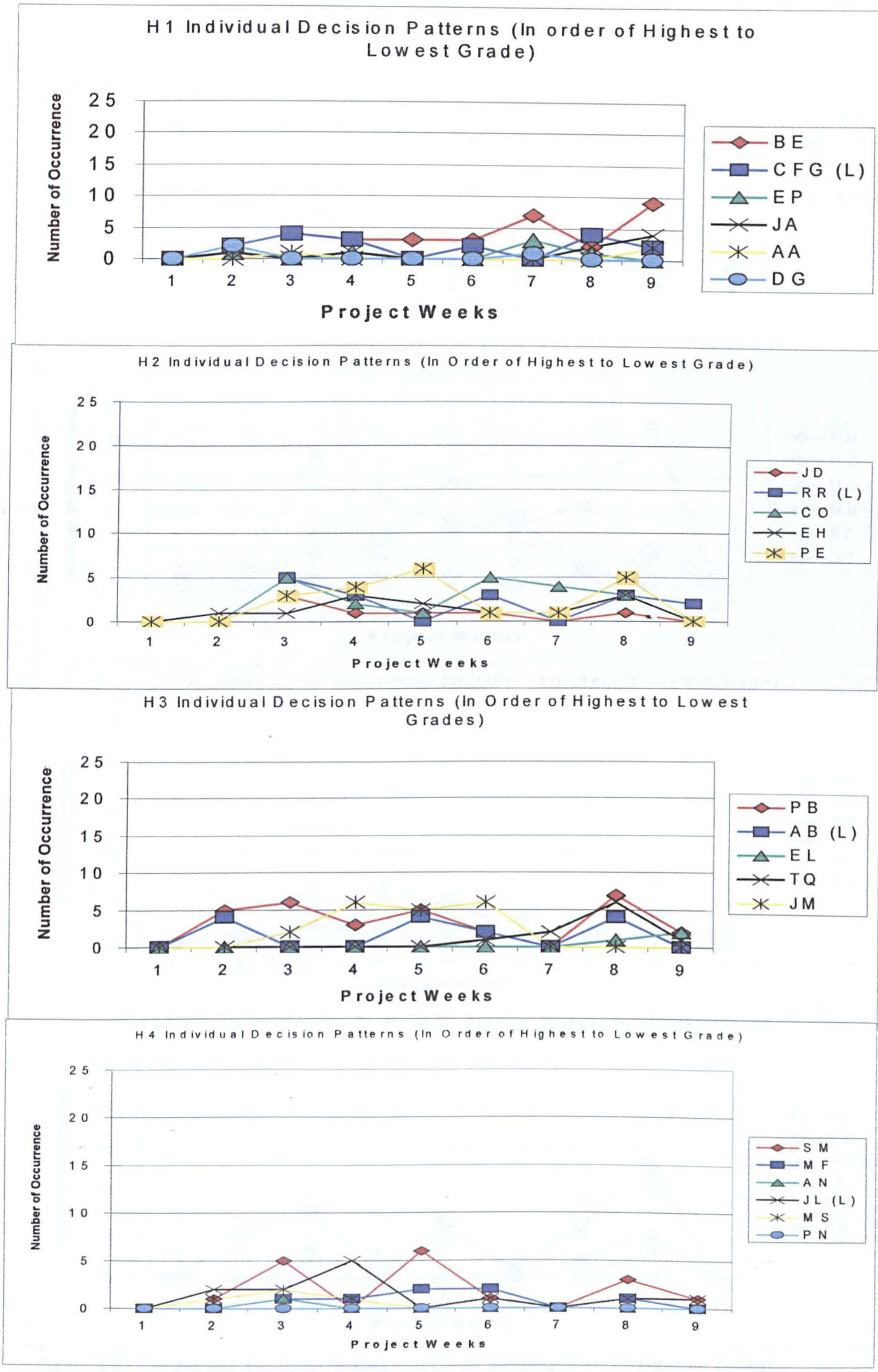


Figure 8.8 - Comparison Decision-Making and Grade Ranking (High Performing Teams)

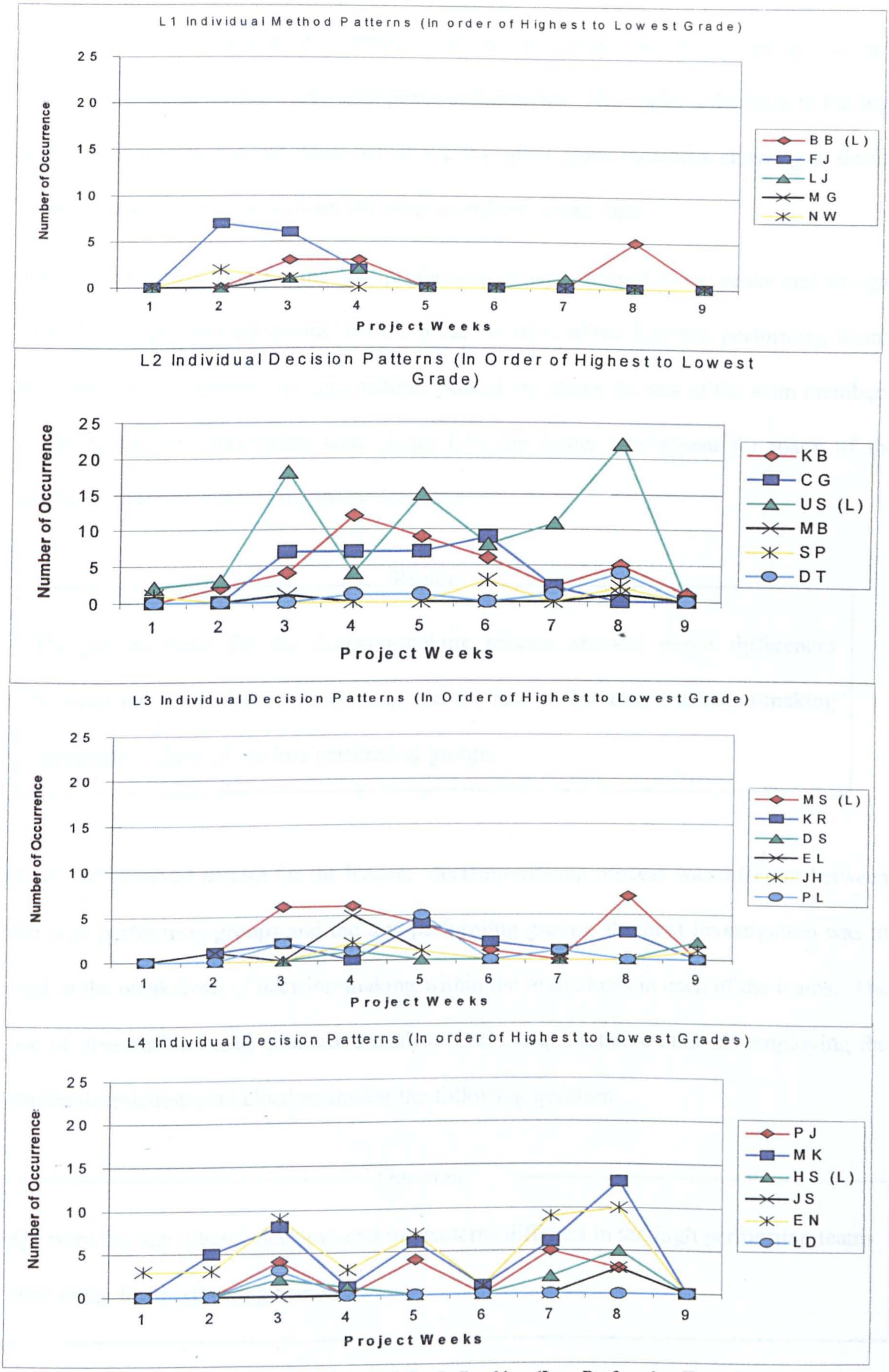


Figure 8.9 - Comparison Decision-Making and Grade Ranking (Low Performing Teams)

The decision-making patterns across time for the high performing groups seemed consistent without having many high peaks and troughs. The leader's decision in the high performing groups did not peak out above the other team members showing a similar decision-making breakdown with the other members across time.

The pattern across time for the low performing groups showed more peaks and troughs than the high performing groups' pattern trend. In three of the four low performing teams, the team leader's decision-making patterns peaked out above the rest of the team members. In the fourth low performing team (team L4), the leader was absent for many of the meetings therefore not making many decisions.

Result

The pattern trend for the decision-making process showed minor differences between the leaders' decision-making and the rest of the team's decision-making especially in three of the low performing groups.

Since the observed pattern for the leaders' decision-making process was different between the high performing groups and the low performing groups, the next investigation was to look at the breakdown of decision-making within the individuals in each of the teams. The use of observation-based qualitative analysis and the quantitative analysis employing the standard deviation test helped to answer the following question

Question

Q - were the individuals' decision-making patterns different in the high performing teams than in the low performing teams?

Figure 8.10 (high performing teams) and **Figure 8.11** (low performing teams) show the decision-making breakdown for the individual members of each team. Again, the legend identifies in descending order the member with the highest grade at the top and the member with the lowest grade at the bottom. The team leaders have a (L) next to their initials.

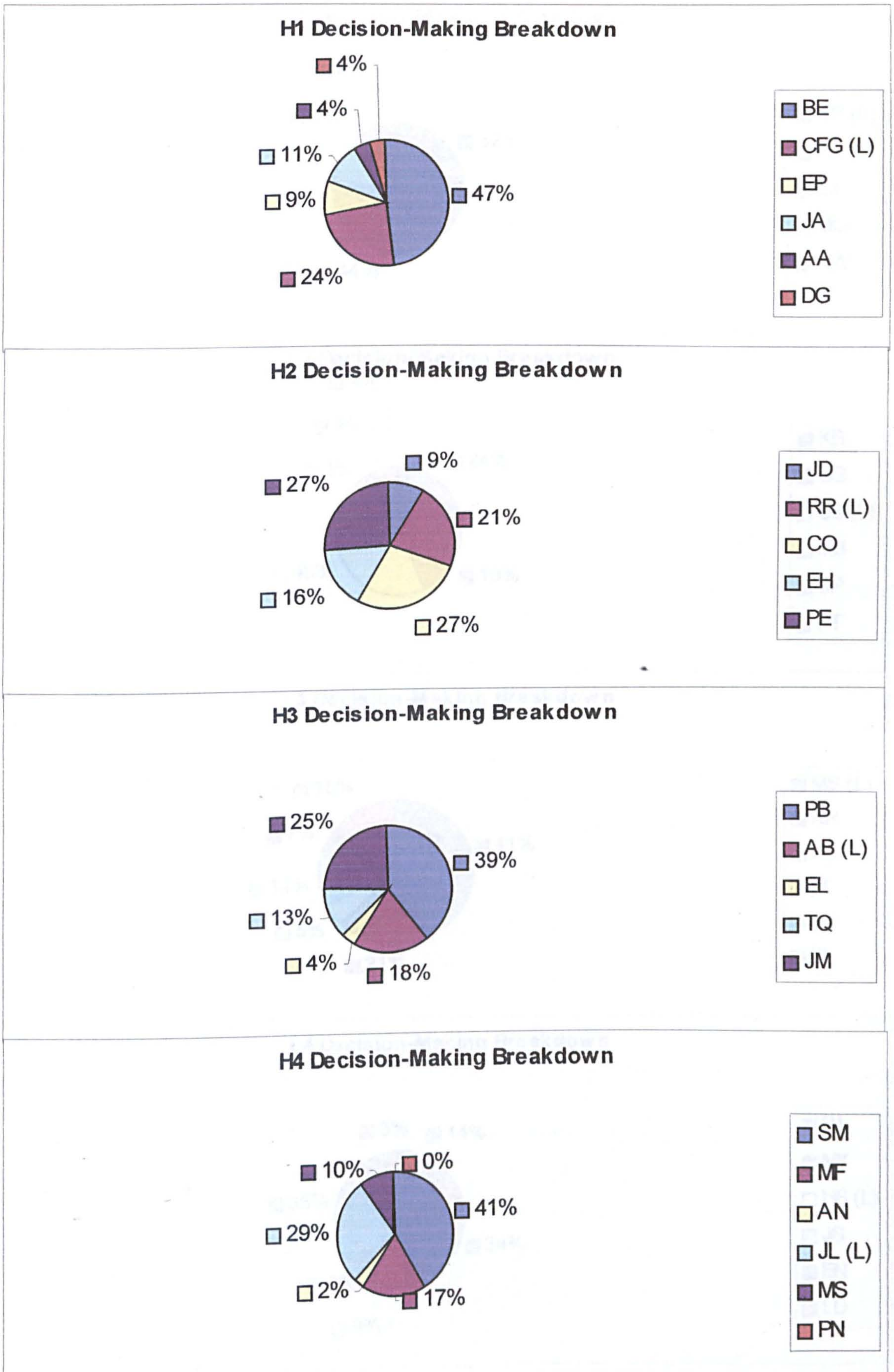


Figure 8.10 - Decision-Making Breakdown (Percentage of Individual Communication for the High Performing Teams)

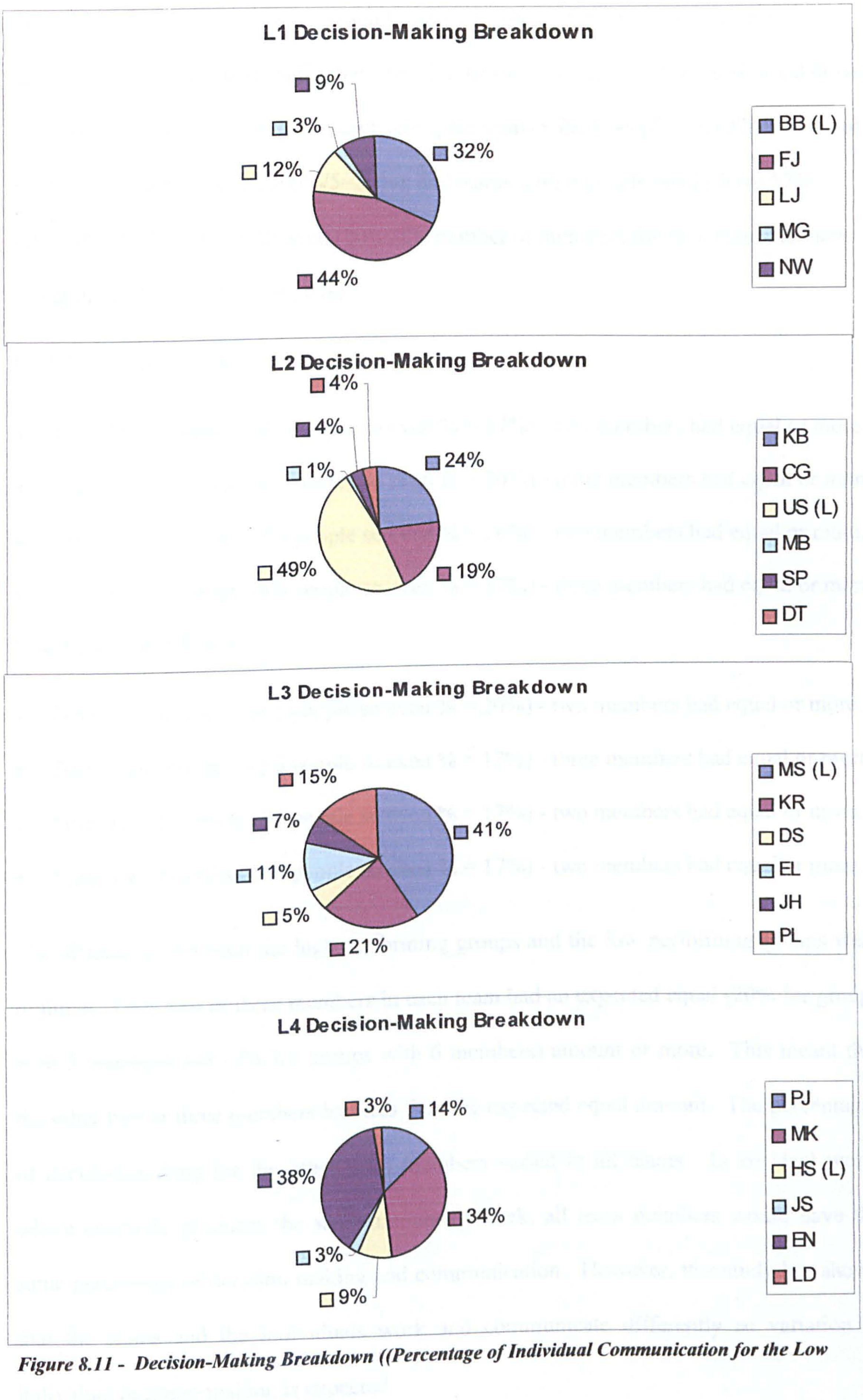


Figure 8.11 - Decision-Making Breakdown ((Percentage of Individual Communication for the Low Performing Teams)

Figure 8.8, Figure 8.9, Figure 8.10 and Figure 8.11 show that the member with the highest grade was not necessarily the one with the most decisions. If an equal breakdown of decision-making is expected in each team, the teams with 5 people would have 20% of the total decision-making (100%/5=20%), and teams with 6 people would have 17% (100%/6=16.6%). The following shows the number of members for each team that have an equal breakdown (17% or 20%).

High Performing Teams

- Team H1 – (consists of 6 people so even % = 17%) - two members had equal or more.
- Team H2 – (consists of 5 people so even % = 20%) - three members had equal or more.
- Team H3 – (consists of 5 people so even % = 20%) - two members had equal or more.
- Team H4 – (consists of 6 people so even % = 17%) - three members had equal or more.

Low Performing Teams

- Team L1 – (consists of 5 people so even % = 20%) - two members had equal or more.
- Team L2 – (consists of 6 people so even % = 17%) - three members had equal or more.
- Team L3 – (consists of 6 people so even % = 17%) - two members had equal or more.
- Team L4 – (consists of 6 people so even % = 17%) - two members had equal or more.

The differences between the high performing groups and the low performing groups were minimal. Only two or three members in each team had an expected equal (20% for groups with 5 members and 17% for groups with 6 members) amount or more. This meant that the other two or three members had less than the expected equal amount. The percentages of decision-making for the other team members varied in all teams. In an ideal world where everyone produces the same amount of work, all team members would have the same percentage of decision-making and communication. However, this study has shown that the teams and the individuals work and communicate differently so variation in individual decision-making is expected.

As the percentage differences were minimal between the teams, it was then decided to look at the spread of the number of decisions made by individuals within each team. The Standard Deviation test was used to calculate the spread or variation of the decisions.

Table 8.9 - Decision-Making Standard Deviation

Standard Deviation on Team Member's Decision-Making Breakdown			
High Performing Standard Deviation		Low Performing Standard Deviation	
Team H1	11.66	Team L1	5.93
Team H2	5.57	Team L2	31.01
Team H3	10.13	Team L3	8.11
Team H4	6.62	Team L4	18.53

The differences for standard deviation across the high performing teams were very small; however, the low performing teams had a wider variation with the lowest standard deviation at 5.93 and the highest at 31.01.

Two teams in each of the high performing groups and two teams in the low performing groups had higher standard deviation results than the other two teams.

Result

The individual team members' decision-making patterns were different in both the high performing teams and the low performing teams. This is consistent with the results in Chapter 5 and Chapter 6 where the teams were different in the amount of communication produced and decision-making.

The high performing teams were similar in the spread of the decisions made (and possibly the work breakdown) by the individual members of each team whereas the low performing teams varied. This was consistent with the observation made in section 8.6.2 where there was a much wider spread of communication among all team members (and possibly work), within the high-performing groups. It was also consistent with the team profile in section

8.3.2 where contribution of work was evenly matched in more of the high performing teams than the low performing teams.

8.7. Chapter Summary

Analysis carried out on each team's profile showed more differences between the high performing groups and low performing groups than similarities.

- Differences in their personal profile showed the high performing groups acknowledged less working hours on the project, more working hours outside of the project and a higher course load than the low performing groups.
- Teamwork experience showed that the high performing groups had a higher average mean percentage of working alone than working with others. In classification, the high performing groups classified themselves more as leaders whereas the low performing groups classified themselves more as *doers*. Contribution of work was evenly matched in more of the high performing teams than the low performing teams. The high performing groups had a higher average mean and total of goals than the low performing groups.
- In CMC (computer-mediated communication), the low performing groups had a higher average mean use of artificial media, which was consistent with the higher percentage of time spent on group work
- In terms of Computer Science experience, the high performing groups had a greater number of known languages than the low performing groups. The team members' opinion of contribution to the CS project was that the high performing groups had a better distribution of work than the low performing groups.
- The similarities between the high performing groups and low performing groups included the CMC (computer-mediated communication) experience and familiarity. There were more students in both the high performing groups and the low performing groups that had never experienced CMC.
- The number of average mean and total expected hours was the same for both the high performing groups and low performing groups with the number of actual work hours per week similar between the two group types. The number of expected hours per week was much less for both group types than the actual project hours worked. The expectation of needed knowledge was expressed by most of the high and low performing groups as a *perfect match* to the knowledge they had.

8.7.1. Group Communication Related to Group Development

There were differences between the high performing groups and the low performing groups in the amounts of communication related to the group development phases. However, in plotting this communication against the relevant group development phases, the peaks and troughs occurred along the same phases for all the teams, displaying generally similar patterns.

8.7.2. Group Development Phase Throughout Time

The occurrence of each group development phase, occurring either sequentially or segmented throughout the timeline supported Poole's suggestion that groups do not follow the same sequence of phases but that different groups follow different sequences.

In negotiating and making decisions, the two types of groups (high and low performing) were similar. However, in identification, sharing information and reinforcing their internal cohesion, the high performing groups were slightly better. This was reinforced by the fact that the low performing groups had more conflict than the high performing groups.

8.7.3. Communication Network

The communication network for all the teams was the same, however, the links and therefore the information exchange for the high performing groups had more solid links than that of the low performing groups.

8.7.4. Leadership Style

More leaders volunteered to be leaders than were suggested by other team members. All of the high performing team leaders were **team leader** types, however, three of the low performing teams had **solo leader** types. The most-used method for decision-making by all the team leaders was method 3 (*decision by expert*) with method 7 (*consensus*) being the second most used. All other methods were evenly used by the low performing groups and high performing groups. Although there were differences in the type of leadership between the high performing groups and the low performing groups, Bennatan (2000) suggests that

> *Some groups succeed, others fail for reasons far beyond the abilities and performances of their leaders.*

8.7.5. Most Frequent Communicator

The main difference between the high and low-performing groups was that in all but one of the low-performing teams, the leader was also the highest communicator. In the high-performing groups, the leader was in the top 3 communicators but was the highest communicator in only one team. These show that there was a wider spread of communication among all team members (and possibly work), within the high-performing teams.

8.7.6. Communication and Grade Ranking

Analyses showed that in 5 out of 8 teams, the individual with the highest grade was also the individual with the highest percentage of communication. The amount of communication per team can reflect the team's focus or lack of focus. The amount of communication by an individual within the team then reflects the individual's contribution. Within the team's communication, regardless of the quantity, the amount of communication by an individual can reflect the measure of work or commitment that individual has put into the project.

8.7.7. Comparison of Decision Making and Grade Ranking

Analyses found different patterns between the high performing group leaders' decisions and those of the low performing group leaders. Further analyses using a standard deviation test, as well as patterns observed, showed the individual team members' decision-making patterns were different in the high performing teams and the low performing teams.

These findings were consistent with the wider distribution of communication within the individuals in the high performing groups than in the low performing groups. This was further reinforced by the team profile reporting an evenly matched contribution of work in more of the high performing teams than the low performing teams.

Chapter 9

Summary of Analyses

9.1. Introduction

Chapter 2 and Chapter 4 identified the techniques used in setting up the Runestone Project and the study for this thesis. Chapter 5 investigated each team's use of communication technology and communication type via a set of categories developed for this study. Chapter 6 analysed the decision-making process for each team in terms of total and types of decisions made across time. Chapter 7 looked at the software development process and Chapter 8 examined each team's structure. This chapter presents summaries of the analyses carried out in Chapters 5 through Chapter 8. After summaries of the analyses, characteristics of the high performing teams and the low performing teams are discussed in terms of how student teams effectively build software at a distance.

9.2. Communication Categories Summary

Chapter 5 studied the communication of all the teams via a set of categories developed and validated for this study. The percent frequency of the communication types showed that all the teams were similar in their use of the top-level categories. However, there were differences in the percent frequency of sub-level categories between all the teams.

Differences between the high performing teams and the low performing teams were evident when the communication types were tracked along the project's timeline. These differences occurred in both the top-level categories and the sub-level categories.

9.3. Communication and Technology Summary

Chapter 5 studied the use of email and IRC by each of the teams. It was assumed that because each team was made up of individuals with different experiences and working habits, their use of email and IRC would differ throughout all the teams. It was further assumed that the high performing teams would have a different use of the communication technology than the low performing teams.

The study used a significance test to check for differences. Four issues were tested.

1. Distribution of total communication for each team.
2. Distribution of totals within the overall high and low performance.
3. Comparison of Email vs. IRC for individual teams.
4. Comparison of Email vs. IRC for overall high and low performance.

- The results of issues 1 and 3 found that all the teams were very different in the amount of communication produced and in their use of the communication technology.
- The result of issue 2 showed that the high performing teams were very different in the amount of communication from the low performing teams. One reason for the differences in the amount of communication (found in issue 1) was that the low performing teams communicated or 'talked' more than the high performing teams.
- The amounts of communication produced by the high performing groups was very different from the amounts of communication produced by the low performing groups. In their use of email and IRC, there were no notable differences between the high performing groups and the low performing groups.

The high performing groups were found to be better organised in their communication than the low performing group.

Another issue of interest was any possible relationship between the amount of communication produced by a team and the team average mark (TAM) calculated in Chapter 4. A test of correlation was conducted on the ranking of the amount of communication for all teams and the ranking of the team average mark (TAM) for all teams. The results show no relationship between the amount of communication and the team average mark (TAM) but there are differences for individuals.

9.4. Decision-Making Summary

Chapter 6 investigated the decision-making process for each team. Chapter 5 found that all teams were different in the amount of communication and the use of the communication technology. It was therefore assumed that all teams would differ in their decision-making patterns. It was further assumed that the high performing groups would have some similarities in the decision-making patterns but would have differences from the low performing groups.

Decision types were identified as implicit or explicit, goal or activity oriented, challenged or agreed. Comparison of the number and timing of these decisions was made for all teams. Analyses showed a similar pattern of total number of decisions across time for all teams except for two of the low performing teams. As predicted, results found that the teams were very different in the total number of decisions made by the 8 teams studied. The total number of decisions made by the high performing teams also showed notable differences with the total number of decisions made by the low performing teams. This supports the differences found in the amount of communication in Chapter 5.

- All teams (both high and low performing) had more implicit decisions than explicit decisions. There were not notable differences in the number of implicit and explicit decisions found either between all 8 teams or between the high and low performing groups. The pattern of use of implicit and explicit decisions throughout the project's timeline showed a greater number of decisions made during the second period.

- All teams (both high and low performing) had more activity-oriented decisions than goal-oriented decisions. No notable differences were found in the number of activity-oriented and goal-oriented decisions between all 8 teams or between the high performing teams and the low performing teams. Previous findings showed that all the teams were different. This was reflected in the differences found in the pattern of use of activity-oriented and goal-oriented decisions between all 8 teams.

- All teams had more agreements to decisions than challenges, however the high performing teams had a higher percentage of challenges than the low performing teams. Differences in the number of agreements and challenges to decisions were found between all 8 teams and between the high performing groups and the low performing groups. The pattern of use of agreements and challenges to decisions throughout the project's timeline again showed a greater number during the second period.

As well as investigating the types of decisions and their timing, Chapter 6 discussed the analyses of the methods used for decision-making strategies by each team. All teams used more than 1 method with the most used methods being; *decision by expert member (M3), minority control (M6), and consensus (M7).* A wide range of patterns was used by each team.

9.5. Software Development Summary

Chapter 7 discussed the team's software development using the waterfall software development model as a guide. Analyses identified the software development phases with regards the starting and finishing points and the sequential (continuous) or segmented (iterative) use throughout the project's timeline. Results found:

- differences in the starting points of phases between the high performing groups and low performing groups.

- the high performing groups began the system engineering (planning) phase earlier than most of the low performing groups.

- the high performing group have a segmented or iterative use of the system engineering (planning) phase whereas 3 out of 4 of the low performing groups have a sequential or continuous use.

- the high performing teams worked on an average mode of 4 phases during the high decision periods whereas the low performing teams worked on an average mode of 5 phases.

- the phases common to all high performing teams during the highest decision points are design and code while design, code and system engineering were the common phases to all the low performing teams.

9.6. Team Structure Summary

Chapter 8 outlined the investigation of each team's structure via a team profile, group development process, communication network, and leadership style. Each team's profile was identified through the questionnaires, logs and journals the students filled out throughout the project. The group development process was identified using Poole's model as a guide.

- Differences in the team profile showed that the high performing teams had less working hours, a higher average of working alone and had more expressed goals. They had a higher number of known languages and had a more even breakdown of work than the low performing teams. The low performing teams had a higher average use of artificial media than the high performing teams.

- Similarities between the high and low performing groups included the experience and familiarity with computer-mediated communication, the number of expected hours to work on the project and the expectation of knowledge required to succeed on the project.

- Differences in the group development process showed that the high performing groups were better in identification with the team, sharing information and reinforcing their internal cohesion. The low performing groups had more conflict than the high performing groups.

- Each group development phase occurred, either sequential or segmented, at different points throughout the project's timeline for all the teams. Thus supporting Poole's suggestion that groups do not follow the same sequence of phases but that different groups have different patterns for development.

- The communication network for all teams was the same. However the links for the high performing teams had more solid links than for the low performing teams further supporting the findings in the group development process where the high performing teams were better at sharing of information

- The leaders in all of the high performing teams and one of the low performing teams were identified as *team leaders* whereas the rest of the low performing teams' leaders were *solo leaders*.

- In three of the low performing teams, the leader was also the highest communicator. In all the high performing teams, the leader was in the top three communicators but was the highest communicator in only one team.
- Although Chapter 5 found that the high performing groups had less communication than the low performing groups, within a team, the highest communicator had the highest grade.
- There was no relationship found between decision-making and grade ranking. The pattern of decisions for individuals within a team was very similar in the high performing groups. In the low performing groups, the pattern was similar for the individuals but the team leaders' decisions peaked out over the rest of individuals.

9.7. Overall Summary

The focus of this study was on how student teams effectively build software at a distance and what characterises high performance in terms of software development in remote student teams in Computer Science. The emphasis on the analyses results were on the high performing groups and the low performing groups. The characteristics of high and low performance found in this study are found in Table 9.1 below.

Table 9.1 - Overall Summary

Chapter	Findings
5	Teams communicated differently and had different amounts of communication. The high performing groups had less communication than the low performing groups. This supports DeSanctis, *et al's* (2001) suggestion that *higher performing global learning teams do not necessarily communicate more, or more often, with one another compared to lower performing teams. More important to success is communicating deeply, with focus, and developing routines of communication and task completion.* The differences in the percentage frequency of the sub-level categories suggest that the teams' were different in the actions they carried out during the project. This helps to support earlier findings where the teams communicate differently. The high performing teams were different in their use of top-level and sub-level categories across time. This is consistent with differences found in each team's use of the software development process. Investigation of each team's communication in Chapter 5 found that the high performing groups were also more organised in the way they conduct their meetings and their work. Bennatan (2000) states that *Badly organised projects breed confusion, and confusion leads to project failure.*
6	Chapter 6 supported the findings in Chapter 5 by showing that teams were also very different in the number of decisions they make. Both high and low performing groups were very similar in the timing and types of decisions as well as the method strategies they used in making decisions except in the agreement and challenges to decisions.
7	The decision-making difference between the high and low performing groups was apparent in the software development as investigated in Chapter 7. The starting points and use (sequential or segmented) of the software development phases were different between the high performing groups and low performing groups as well as the timing of the decisions while working on specific software development phases. The differences found between the high performing groups and low performing groups suggest that the management of the software development process as a whole is crucial to the successful outcome.
8	Team profiles identified in Chapter 8 showed similarities between the high performing groups and the low performing groups in experience and familiarity of computer-mediated communication and project expectations. The less working hours reported by the high performing teams suggest a focus in their work. This is consistent with the amount of communication they produced, the better organisation of their meetings, and the findings of the high performing teams' software development process. Team profiles and analysis on the group development process found that the high performing groups had less conflict and shared information better than the low performing groups. This was further supported by the findings on the communication network. The leadership style was also found to be different between the two types of groups. This was further seen in the analysis of the highest communicator where the leaders in the low performing groups were also the highest communicators possibly monopolising the communication. The highest communicator within each team was also the individual with the highest grade.

Research Results

The study's focus on how student teams effectively build software at a distance can be answered by the findings in the differences between the high performing groups and the low performing groups in the software development process. The high performing groups were more focused on the tasks such as planning (SE) and not doing too many things at the same time. An effective use of the software development process can also mean that key decisions are made during the times in the software process where they will be most effective.

Research Results

The study's focus on what characterises high performance in terms of software development in remote student teams in Computer Science can be answered by the analyses on communication, decision-making, team structure and leadership style as well as the use of the software development process outlined above. The characteristics of high performing teams in terms of software development in remote student teams in Computer Science found in this research are summarised below.

- High performing teams were more organised in their work so they communicated less, had fewer decisions and therefore had less working hours. Although the high performing teams had less communication, they had similar a percentage of socialising as the low performing teams.
- High performing teams were better at sharing information and had less conflict.
- High performing teams had a leadership style that was more suitable to teamwork than the low performing teams.
- High performing teams had an even spread of communication, participation and work breakdown.
- Although the high performing teams reported a wider knowledge of known computer languages, the backgrounds in experiences between the high performing teams and the low performing teams were similar. The process (actions and timing of tasks) in the software development was crucial to a successful outcome.

Chapter 10

Conclusion

10.1. Introduction

Chapter 4 through Chapter 8 conducted analysis on the type, the amount and organisation of communication as well as decision-making and software development patterns of the teams from the point of high and low performance. It also looked at the team structures, the leadership styles, and communication. Chapter 9 summarised the findings of previous chapters from the point of view of how student teams effectively build software at a distance and what characterises high performance in terms of software development in remote student teams in Computer Science. This chapter reviews the research questions identified in Chapter 1 and discusses the extent to which these questions have been answered by this study.

10.2. Research Questions

1. *Do the group development models developed for face to face teams apply to remote teams?*

   Although previous research on group development differs in terms of models, they all agree that groups or teams go through certain phases where their relationship changes. Studies for previous research have been conducted in a face to face environment. Analysis carried out in Chapter 8 showed that groups or teams in a remote environment also go through a process of change in their relationship. The analysis also supports Poole's group development model in its suggestion that groups don't have a particular sequence of stages. Although each team went through specific development phases, the pattern differed for each team. These analyses suggest that group development models developed for face to face teams apply to remote teams.

2. *What determines a high or a low performing team?*

   Performance is measured differently depending on the project and the environment. Not only is performance measured differently between industry and academia but it is also measured differently within academic courses. When teachers set a particular course, they are looking for performance factors specific to the course they set. The analysis outlined in Chapter 4 looked into the performance factors set by the teachers who set the courses in this study. What determined a high performing team or a low performing team in this study, was based on the performance factors identified when the course or the project goals were set.

3. *What characterises the interactions of high performance and low performance groups?*

   Analyses described throughout Chapters 5-8 investigated similarities and differences in interaction patterns of high and low performing groups. The results found particular characteristics, which differentiate between high performing groups and low performing groups. Chapter 9 gave a more detailed summary of each chapter's findings. An outline of these characteristics is:

   - The high performing groups had less communication but were more organised than the low performing groups. This supports studies by Bennatan (2000) and DeSanctis, *et al* (2001). Bennatan believes that lack of organisation breeds confusion and confusion results in project failures. DeSanctis, *et al* states that high performing teams usually have less communication than low performing teams.

   - The process and timing of the software development and key decision-making was more focused for the high performing groups.

   - The communication links between the individual members of the high performing teams are better than the low performing teams.

- The leaders for all the high performing groups and one low performing group, were identified as *team leaders.* The leaders for three of the low performing groups were *solo leaders.* Belbin (1996) suggests that the teams who have a *team leader* will have a *brighter future* than those with a *solo leader.*

4. *Does the amount of communication affect a team's performance?*

In order to achieve the goals set on a team project, the members of the team must communicate with one another. Each team produces different amounts of communication, however the total communication type pattern was very similar for all teams as shown in Chapter 5. Previous research showed that high performing teams had less communication than low performing teams. The analyses carried out for this study supports this, as the high performing group was identified as having less but more focused communication. Analyses in Chapter 8 also found that the highest communicator had the highest grade.

5. *What characterises the software development process of high performing and low performing teams? Are interaction patterns specific to different phases of software development?*

Using the Waterfall Software Model as a guide, Chapter 7 investigated the software development process for each team involved in this study. Results showed that there were differences in the use of the process between the high and low performing groups. It also identified different timing of specific phases between the high and low performing groups.

6. *Are there any specific decision-making patterns that characterise high or low performing groups?*

Chapter 6 investigated the decision-making process of each team. Findings of the decision-making types and patterns did not show notable differences between the high and low performing groups. Differences in the decision-making process between the high and low performing groups were found when looking at high decision points within the software development process in Chapter 7. During the week when the most activity-oriented and goal-oriented decisions were made, the high performing teams were working on a different number of phases than the low performing teams. All the teams were different in the way they made goal-oriented and activity-oriented decisions.

7. *Does interaction between only some members of the group achieve a successful result?*

Teams are made up of individual people who have different experiences and different work habits. Chapter 8 investigated the structures of interactions in each of the teams. The teams in the high performing groups had unbroken communication links whereas the teams in the low performing groups had broken communication with at least one member. The broken communication link in the low performing teams meant that work was delayed or did not get done. Within this analysis, interaction between only some members of the group did not achieve a successful result.

10.3. Research Considerations

This research recognises the possibility of bias or limitations. Great care was taken throughout the analyses of this research study to ensure the authenticity of its findings by validating and checking for the reliability of the coding scheme, reviewing the work and exposing it to critique and checking against published standards. The set of categories developed were verified and validated before they were used and all significance and standard deviation tests were checked for accuracy.

Validity of quantitative analysis in this research ensured that not only was the measurement (tests used) correct for the analysis but that numerical measurements were done correctly. Validity of qualitative analysis in this study ensured that the interpretation of the communication generated by the teams was one that could be shared by more than just one researcher. The agreement of interpretation was important in order to verify and validate the category framework. Interpretation here must in a sense present a recognisable likeness of reality (Mason, 1989).

In research, reliability deals with the ability to repeat or replicate findings or measures with similar results (Coolican, 1999). In this study, the issue of reliability was most concerned with the categories and sub-categories created. It was important that coding of interaction resulted in the same or similar sub-categories when the coding of the same communication was replicated by more than one person.

10.3.1. Research Generalisability

As mentioned earlier in this thesis, there are several studies set in contexts similar to the context in this research. Other studies have looked into the individual areas of group development, software development, teams working at a distance and project performance. Techniques used in many of these studies vary from investigation of the communication via categories to looking at the software artefacts (e.g., code and design) and the tools used in software development.

This research was set in the context of software development in teams at a distance. The context of this research differed in that it encompassed a combination of the studies identified above. This study also used the technique of analysing communication via categories however this research differed in that it used categories that are specific to the research context. This study also differed in that it was task specific and was interested in what was happening within the group, how the group developed as a team, what key decisions were made and how this affected the development of software.

The results found in this research were validated within the research itself and were consistent with findings in previous studies. Two examples of this validation with previous studies were

- the group development process found in this research was consistent with Poole's (1981) group development findings
- the difference in the amount of communication between the high performing groups and low performing groups were consistent with DeSanctis, *et al* (2001) group communication findings.

The high performing teams provided an empirical software development process for teams working in a distributed environment. The high performing teams followed an iterative waterfall software development process. They also demonstrated the importance of ensuring that proper system engineering is done in the early stages, and the importance of effective communication.

The research project also contained real-world development elements such as real-time control, web-based systems, and was implemented in languages commonly used in industry.

The findings are believed to be generalisable to other institutions and other educational applications set in similar contexts.

10.3.2. Research Repeatability

The research has shown possibilities for repeatability. The coding scheme was validated and checked for reliability therefore showing stability. The coding scheme was developed with examples and coding guidelines to aid in the coding.

The results of this research were validated using different analyses carried out on different areas. For example, findings in the amount of communication were consistent with the findings in the amount of decisions.

Although it would be a big undertaking, it is believed that using similar techniques in a similar context, repeating this research would result in similar findings.

10.4. Further Work

This research has investigated the communication, decision-making, software development process and the structure and make up of 8 teams identified as high or low performing. The findings that resulted from these analyses supplement findings of previous similar studies. Research in this area, however, must continue to advance to keep pace with the advances made in technology. Although the investigation in this research involved several different areas, it raises particular issues and questions, which could benefit from future work. This takes into consideration further work on the material covered by this research and issues that will address the concern of generalisability discussed in section 10.3.1 above.

- Although each team produced large amounts of communication, when looking at high and low performing teams, this research looked at the maximum of 4 teams in each type of performing group. Analysis of more groups would be beneficial especially in areas where there were marginal results such as 3 out of 4 teams.

- The analysis used for researching the large amounts of communication was inductive analysis. Further work in the analyses area will be to use other techniques such as speech act theory.

- In this research, there was one group that had a much larger amount of communication than any other team. How are the present results affected if this team had an amount of communication that was within the range of the other teams?

- This research looked at the decision-making process in terms of the different types of decisions, the amount of decisions, the methods used and their effect on the software development process. A further interest in decision is to look at the quality of the decisions. In other words, are they good decisions or bad decisions.

- This research looked at the team's structure and the individual team members in terms of their past experiences and their contribution to the team. An interest for future work is to look further at the individual's role. This issue raises the following questions.

  How do the individual's marks affect the team marks?

  Does the individual's personal goals interfere or have an affect on the team goals and therefore the performance?

  How would an imbalance of experience affect the group development and the team performance? Would the team be split into the technical people and the non-technical people?

  How does the amount of communication for each individual compare with the individual's communication type (actions as seen in the sub-categories)?

- A correlation between the amount of an individual's communication and their grade was found in this study. Further interests in this area include studying the relationship between communication and grade from the point of view of cause and effect and comparing the grade components such as milestone grades and project functionality with the category communication types for each individual.

- The software development model in this research was reflected in the structure of the course. Would the outcome be the same if the course structure did not reflect a particular software model, for example, if there were no milestones? Would the students follow any particular model and what effect would different models have on the research results?

An aim of this study was to give a likeness of reality to the interpretation of the data so that the results have some generalisability to other similar projects. The Runestone Project is only one of a growing number of projects that are investigating international collaboration in education. Having some generalisability, this study can produce patterns for effective team building of software and characteristics of high performing groups or low performing groups that can be used in other similar projects. With further research, it may be possible that the generalisability of this project can move from education to industry where there is currently a great deal of software development in remote groups.

Future work will involve developing this study further in order to move from education to industry where communication, remote or face to face, can be confusing, time consuming and on occasions unnecessary. Movement from an educational environment to industry will require investigation of the performance criteria, which differs between education and industry. It will also require investigation of the team profiles because professionals may have more or different experiences than the students have.

Some questions for future research in industry include:

- How much communication and what type of communication is needed for each organisational level (e.g. project manager, developers) during a software development project?
- Do the developers need the same type of information as the project managers?

Other ways of investigating the relevant issues in this research without duplicating the lengthy research techniques include reviewing the software development process in terms of management. This encompasses the project schedules and the software artefacts (such as the design and code) throughout the project. This would help to give an idea of what is happening within the group and their software development process.

10.4.1. Recommendations

Having identified some patterns for effective team building of software and characteristics of high performing groups or low performing groups that can be used in other similar projects, a few recommendations can be made from these findings. Education and industry should

- recognise the importance of communication and organisation skills in a group environment and encourage proper development of these skills.
- provide skills on team working especially in more formal cultures where deference can impede effective communication.
- have an awareness of project management and the software development process.
- support high performance by providing the
  the right technology to accomplish a task at the right time...for global virtual teams. Dube and Pare (2001).
- assigning proper allocation of responsibilities with clear delineation of boundaries to avoid duplication of effort and ensure proper integration.

This research found that communication is not inherently useful. It is communicating the right information at the right time.

10.5. Conclusion

This research focused on how student teams build software at a distance. It was also interested in what characterises high performance in terms of software development in remote student teams. The research tracked the progress and changes in the entire electronic communication for 8 teams identified as the 4 highest and 4 lowest performing in the 2000 presentation of the Runestone Project. A set of categories was developed to characterise the communication for each team. Using inductive analysis techniques each team's decision-making, group development, software development and team structure and interaction were analysed.

Results showed that communication and the timing of specific actions were crucial to a team's success. The management of the software development process with key decisions made during the right times would be most effective.

Institutions need to provide students not only with the techniques of software development such as project management skills but also with the skills required to work in the current environment. Techniques alone do not determine a successful outcome. A successful outcome is determined by a combination of knowledge and skills.

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Appendices

Introduction to Appendices

The numbering of these appendices is such that the leading figure corresponds to the chapter to which the information in the particular appendix relates. For example, Appendix 4.1 is the first Appendix item for Chapter 4, Appendix 4.2 is the second Appendix item for Chapter 4, and so on.

Appendix 4.1 Runestone Project – Background Questionnaire

PLEASE NOTE: *The original of this form was implemented as a web data collection form using radio buttons, scrolling text boxes, drop down lists and macros. Owing to technical limitations it has been re-created here only as a static document.*

Runestone Project

Background Questionnaire Winter 2000

This questionnaire is designed to give information that will improve the way group projects are run in the classroom. Your replies will be treated with strict confidentiality; please be frank and honest. Only the fact that you did or did not complete the questionnaire will be relayed to your instructor. The instructor will not see any responses until after the course is completed and grades are posted.

The form will take about 30 minutes to complete.

Section A - Computer Mediated Communication

1. How much have you used the following media?

	never	**at least once**	**many times**
Video-conferencing	o	o	o
Audio-conferencing	o	o	o
Shared Applications (e.g. electronic whiteboards)	o	o	o
Electronic Mail	o	o	o
Computer Conferences	o	o	o

2. On the project, your team may use the following media to do collaborative work. How **familiar** are you with each of the following?

Check the rating that best describes you, from 1 = unfamiliar to 5 = very familiar)

	UNfamiliar				**familiar**
Video-conferencing	o	o	o	o	o
Audio-conferencing	o	o	o	o	o
Shared Applications	o	o	o	o	o
Electronic Mail	o	o	o	o	o
Computer Conferences	o	o	o	o	o

3. For each of the media listed below, fill in the number that tells how **helpful** you think it will be in the following activities.

1 = no help at all .... 5 = very helpful

	video-conference	audio-conference	shared applications	electronic mail	computer conference
Interpreting the problem to be solved	--	--	--	--	--
Considering alternative approaches	--	--	--	--	--
Agreeing on an approach	--	--	--	--	--
Showing that the approach solves the problem	--	--	--	--	--
Establishing roles/dividing up the work	--	--	--	--	--
Getting acquainted with your collaborators	--	--	--	--	--
Getting work done	--	--	--	--	--
Resolving misunderstandings	--	--	--	--	--
Seeing things in new ways, gaining insights	--	--	--	--	--

Section B - Working in a Group or Team

1. In general, how do you feel about **working with other students?**

prefer it
like it sometimes
tolerate; it's okay
don't like it much
strongly prefer to work alone

2. In a typical week, what percentage of your study time (excluding lectures and laboratories) do you spend:

Studying **alone** ______ %

studying **with one friend** ______ %

studying **with a group** of friends ______ %

Total = 100%

3. How **often** have you worked in a group to do the following activities?

	never	at least once	many times
a team project	o	o	o
solve problems (work examples)	o	o	o
a laboratory exercise	o	o	o

4. When you have worked on teams, which aspect has given you the **most satisfaction**?

- o have never really worked on a team
- o social outcomes (making new friends, interacting, and so forth)
- o technical outcomes (job was well done)
- o both the social and technical outcomes in fairly equal amounts
- o simply completing the assignment or doing the assigned job
- o Other

5. If you chose "other" from the list above, please be specific about the aspect that gives you the most satisfaction:

6. When you work in a group (whether formally or informally), how frequently do you find yourself doing the following activities?

	Never	some, but less than other people	about the same as other people	more than other people
Initiating ideas	o	o	o	o
Explaining	o	o	o	o
Resolving differences	o	o	o	o
asking for information	o	o	o	o
asking for explanations	o	o	o	o
Listening	o	o	o	o
Summarizing	o	o	o	o
Taking notes	o	o	o	o
Leading	o	o	o	o
doing the work	o	o	o	o

7. For each attribute pair, please check the one that best describes you. Would you characterize yourself more as:

theoretical o	Or	o practical
an introvert o	Or	o An extrovert
a do-er o	Or	o a thinker
methodical o	Or	o intuitive
analytical (break things into parts) o	Or	o holist (consider things as a whole)
calm o	Or	o excitable
easy-going o	Or	o stubborn
Tolerant of risks o	Or	o avoid risks
doing things because you want to o	Or	o doing things because they are expected
Talkative o	Or	o quiet
enjoy beginning a project more than the end o	Or	o enjoy finishing a project more than beginning

8. Please identify three **advantages** of working with other students:

9. Please identify three **disadvantages** of working with other students:

10. Please describe an **effective** group:

11. Indicate your agreement with the following statement:

"Getting to know the remote members of the group will make group work more manageable."

- O strongly disagree
- O Disagree
- O Unsure
- O Agree
- O strongly agree

12. How important do you think it is to be able to **speak a foreign language** well?

- o Not very important
- o Not important
- o No idea whether it's important or not
- o Important
- o Very important

13. How important do you think it is to be able to **understand a foreign culture** well?

- o Not very important
- o Not important
- o No idea whether it's important or not
- o Important
- o Very important

14. What do you anticipate that you can **learn** from the remote students that you can't learn from students in your own country?

15. Brainstorm some activities that might help you get to know the remote members of your team.

16. For each of the following questions, please answer for group work in general, and international group work in particular (if you have no experience, please speculate):

What's the **best** part of group work?

What's the **worst** part of group work?

What are the most **useful** things you as individual can do to ensure that the group gets the work done?

What do you expect is most likely to go **wrong** in group work?

Section C - Computer Science Experience or Background

1. For each of the CS topic areas listed below, consider your knowledge in the following contexts:

1 = less than 2 = perfect match 3 = better than

CS Topic	your knowledge compared to standards of your own university	your knowledge compared to standards of the other university	your knowledge in the context of what you need to complete this project
Java Programming	--	--	--
C/C++ Programming	--	--	--
Software Engineering	--	--	--
Distributed Systems	--	--	--
Data Communications	--	--	--
Network Programming	--	--	--
OO Programming	--	--	--
GUI client/web development	--	--	--
Systems Programming in Linux/Unix	--	--	--

2. What **knowledge** do you have that will make a contribution to the project?

3. What Computer Science concepts do you expect to **learn** during this project?

Section D - Student Data

1. What are your **personal goals** for this international team project (other than getting a good grade)?

2. What is your name?

3. What is your email address?

4. Are you a student at o Uppsala or o GVSU?

5. To which team are you assigned? --

6. Describe your course load for this semester (how many courses/credit hours; types of courses):

7. How many hours per week (on average) do you think you will spend on this project?

O 1 - 5 hours O 6 - 10 hours O 11 - 15 hours O more than 15 hours

8. For each week that you work on this project, what percentage of your project time (excluding lectures and laboratories) do you think you will spend:

working on the project **alone** %

working **with one other person** %

working **with your group** %

total = 100%

9. How many hours per week do you work (non-school)?

- o Do not work
- o 1 - 5 hours
- o 6 - 10 hours
- o 11 - 15 hours
- o 16 - 20 hours
- o more than 20 hours

10. Is there something about team work, computer mediated communication, or your CS background that we have not asked that you feel is important? Do you have any other comments to share?

Thank you for submitting the requested information Your honest replies will help us to understand how best to run group projects for students. If you have questions about the form or the use of the data, please email Mary Last.

Click the Submit button to record your responses. Click Reset to start over.

Appendix 4.2 Runstone Project – Project Logs

Runestone Project Log 2000

This log focuses on two things; time-on-project and interactions. It should be an on-the-spot log that you complete for each period of time you spend on project work, as you finish that period. (However, if you fill it in from memory later, please indicate that in the space provided.) It should be a quick, habitual exercise, about a minute per entry. You might find it easiest to keep the log form open whenever you work. The log is designed so that you can use it more than once a day if necessary.

Month: ○ January ● February ○ March ○ April

Day:

○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7	○ 8	○ 9	○ 10
○ 11	○ 12	○ 13	○ 14	○ 15	○ 16	○ 17	○ 18	○ 19	○ 20
○ 21	○ 22	○ 23	○ 24	○ 25	○ 26	○ 27	○ 28	○ 29	○ 30
○ 31									

Type of Work: (check all that apply)

- ☐ alone
- ☐ with one other person
- ☐ with subgroup
- ☐ with entire team

Communication Medium: (check all that apply)

- ☐ None Used (time was spent reading, studying, writing code, debugging, etc.)
- ☐ Face to face
- ☐ Internet Relay Chat (IRC)
- ☐ E-mail
- ☐ Web-based Discussion Forum
- ☐ Whiteboard
- ☐ Videoconference
- ☐ Telephone Conversation
- ☐ Other: Please specify:

Duration: (How long did you work?) Please select the time from the drop-down boxes. Time is divided into hours and minutes. For example, if you worked only 15 minutes, select 0 from the hour drop-down list and 15 from the minutes drop-down list. If you worked 2 hours, select 2 from the hours list and 0 from the minutes list.

Hours: [select one] **Minutes:** [select one]

Brief Description: (What were you doing?) Provide a brief description of the type of work you were doing, for example, writing code, writing documentation, debugging.

For what **time period** are you reporting your time, that is, does this time log reflect work done today or work done on a previous day(s)?

○ Today ○ Work done previously

What is your name?

What is your team number?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8

○ 9 ○ 10 ○ 11 ○ 12 ○ 13 ○ 14 ○ 15 ○ 16

Thank you for submitting the requested information. If you have any questions about the form or the use of the data, please contact Mary Last.

Appendix 4.3 Runestone Project – Journals or Interval Logs

Brio Journal #1

Date Due: Thursday, February 24, 2000

All journal entries are confidential and will not be shared with either Carl or Arnold during the course. Please be honest in your responses. Thank you!!

Send your journal entry as plain text in the body of an email message to Mary Last (last@acad.stedwards.edu). The subject heading should be in the format `TnnJ1:Last-Name` where `nn` is the number of your team and `Last-Name` is your last name. For example, if Anders Berglund is in team 1, his subject heading will be `T01J1:Berglund`. Note that there is no space between the colon and the last name.

For many of you, this may be your first experience in writing a journal. In many ways, a journal is similar to a diary that you might keep. Don't be intimidated and don't worry about perfect spelling or grammar. Read each of the questions below and answer it honestly and thoughtfully. If you need help or a better explanation, please e-mail Mary Last (last@acad.stedwards.edu).

Content of the Journal Entry

Roles: Each team member usually plays some type of role(s). One person may be the team leader. Another person may be the idea person. Another person may be good at detail while still another may play the role of devil?s advocate. What role(s) do you think you will play in your team? Why?

Completed Activities: By now, you should have completed the Brio Project design document and be working toward your next milestone. What was your contribution to the design document? What new skills or computer science concepts have you learned from this phase of the project? What skills or computer science concepts were enhanced during this phase of the project?

Communication: One of the key aspects of team success is communication. How do you feel about the communication within your team? Which tools have you used (IRC, NetMeeting, email, others) and how useful do you think they are?

Initial Impressions: Briefly describe (2 - 3 sentences) each of your team members in terms of their ability to contribute to the team.

Brio Journal #2

Date Due: Friday, March 17, 2000

All journal entries are confidential and will not be shared with either Carl or Arnold during the course. Please be honest in your responses. Thank you!!

Send your journal entry as plain text in the body of an email message to Mary Last (last@acad.stedwards.edu). The subject heading should be in the format TnnJ2:Last-Namewhere nnis the number of your team and Last-Name is your last name. For example, if Anders Berglund is in team 1, his subject heading will be T01J2:Berglund Note that there is no space between the colon and the last name.

Recall that writing a journal is similar to writing in a diary. Don't be intimidated and don't worry about perfect spelling or grammar. Read each of the questions below and answer it honestly and thoughtfully. If you need help or a better explanation, please e-mail Mary Last (last@acad.stedwards.edu).

Content of the Journal Entry

Completed Activities (technical): By now, you should have completed the motor control and video processing portions of the project and be working toward your next milestone.

- What technical problems did the team encounter on the motor control piece?
- What technical problems did the team encounter on the video processing piece?
- What was your contribution to each of these deliverables?
- What new skills or computer science concepts have you learned from these portions of the project?
- What skills or computer science concepts were enhanced during these portions of the project?

Completed Activities (team process):

- Describe the dynamics of your team.
- What decisions did you have to make as a team to do the motor control portion?
- What decisions did you have to make as a team to do the video processing portion?
- Did you all agree on what should be done?
- How did you reach that agreement?
- Do you feel your team is working at its full potential?

Class Matters:

- How do *you* feel about this class (CS467 or Datorsystem II)?
- What have you really enjoyed about the class?
- What is bothering you?
- What effect is the class having on the rest of your life?

Student Evaluation of CS467 and Datorsystem II

Brio and the Runestone Project

Thank you for your participation in the Runestone project. Please answer the following questions about the project and your personal involvement in it. Your answers don't need to be lengthy but they should be honest and frank. Your experiences will help other students who participate in similar projects. All entries are confidential and will not be shared with either Carl or Arnold until after you have received your course grade.

The class project your team has just completed had these major aspects:

- Team goal (the successful completion of the Brio project)
- International collaboration (the Runestone aspect)
- Team process (working in teams in general)

We are interested in your views on all of these points. Don't worry about perfect spelling or grammar. Read each question below and answer it honestly and thoughtfully.

If you are answering these questions in the classroom, simply handwrite your responses underneath the question. Use extra paper if necessary. If you are accessing the evaluation form from the web, download the web page, insert your responses, and save the file. Then, attach the file to an email message and mail to Mary Last (last@acad.stedwards.edu). If you prefer, you can insert the answers in the body of an email message.

Individual Outcomes

1. Which part(s) of the project gave you the most satisfaction (that is, what made you feel pleased with yourself?)

2. Which part(s) of the project gave you the least satisfaction?

3. If you started from the beginning knowing what you know now, what would you do differently? Why?

4. Overall, how do you feel about your involvement in the project?

Team Outcomes

In the next two questions we ask you think about how successful your team was from two different points of view.

5. If you define success as *completing the technical requirements of the project*, rate your team's success on a scale from 1 to 10 where 1 = failure and 10 = complete success.

   1 2 3 4 5 6 7 8 9 10

6. If you define success as *learning how to work in a team with people of different cultures* in different locations, rate your team's success on a scale from 1 to 10 where 1 = failure and 10 = complete success.

   1 2 3 4 5 6 7 8 9 10

7. Do you feel like you really got to know your local teammates? Why or why not?

8. Do you feel like you became well acquainted with your remote teammates? Why or why not?

9. In your first journal entry, you gave your initial impressions of the other members in your team. What are your impressions now?

10. What do you feel was the most severe problem that your team encountered during the project? (Some ideas to get you thinking: technical, cultural, communications-related, member participation, technical preparation, course policies...)

Technical Learning Outcomes

11. What computer science concepts or technical skills that you knew before starting the project helped you in the course?

12. What computer science concepts or technical skills did you learn during the course?

13. In the background questionnaire, you compared your knowledge and that of your remote counterparts. Now that you've completed the course, we want you to compare your knowledge in the following areas by circling the appropriate number:

1 = less than 2 = perfect 3 = better than

Computer Science Topic	Your knowledge compared to standards of your own university	your knowledge compared to standards of the other university	your knowledge in the context of what you needed to complete this project
A) Java Programming	1 2 3	1 2 3	1 2 3
B) C/C++ Programming	1 2 3	1 2 3	1 2 3
C) Software Engineering	1 2 3	1 2 3	1 2 3
D) Distributed Systems	1 2 3	1 2 3	1 2 3
E) Data Communications	1 2 3	1 2 3	1 2 3
F) Network Programming	1 2 3	1 2 3	1 2 3
G) OO Programming	1 2 3	1 2 3	1 2 3
H) GUI client/web development	1 2 3	1 2 3	1 2 3
I) Systems Programming in Linux/Unix	1 2 3	1 2 3	1 2 3

Advice for the Future

14. What advice would you give to a student who was going to do this project next year?

15. What advice would you give to the faculty who teach this course next year?

16. Independent of the project topic (Brio), would you recommend that the senior project be run in Runestone mode, that is, as a collaboration with students in another university in the future? Why?

17. Independent of the Runestone mode of the course, would you recommend that the senior project be a hardware/software project, such as the Brio project. Why or why not?

Closing Thoughts

18. What else would you like to tell us that we haven't asked you specifically?

Again, thank you for your participation!

Appendix 4.4 Danziger and Bales Category Models

Bales Category Model (Bales and Strodtbeck, 1951)

Bales' Set of Observation Categories

Socio-emotional area:

Positive reactions

1 Shows solidarity; raises other's status; gives help and reward

2 Shows tension release; jokes, laughs, and shows satisfaction

3 Agrees, showing passive acceptance; understands, concurs, and complies

Task area:

Attempted answers

4 Gives suggestion and direction, implying autonomy for others

5 Gives opinion, evaluation, and analysis; express feelings and wishes

6 Gives orientation and information; repeats, clarifies and confirms

a b c d e f

Task area:

Questions

7 Asks for orientation, information, repetition, and confirmation

8 Asks for opinion, evaluation, analysis, And expression of feeling

9 Asks for suggestion, direction, and possible ways of action

Socio-emotional area:

Negative reactions

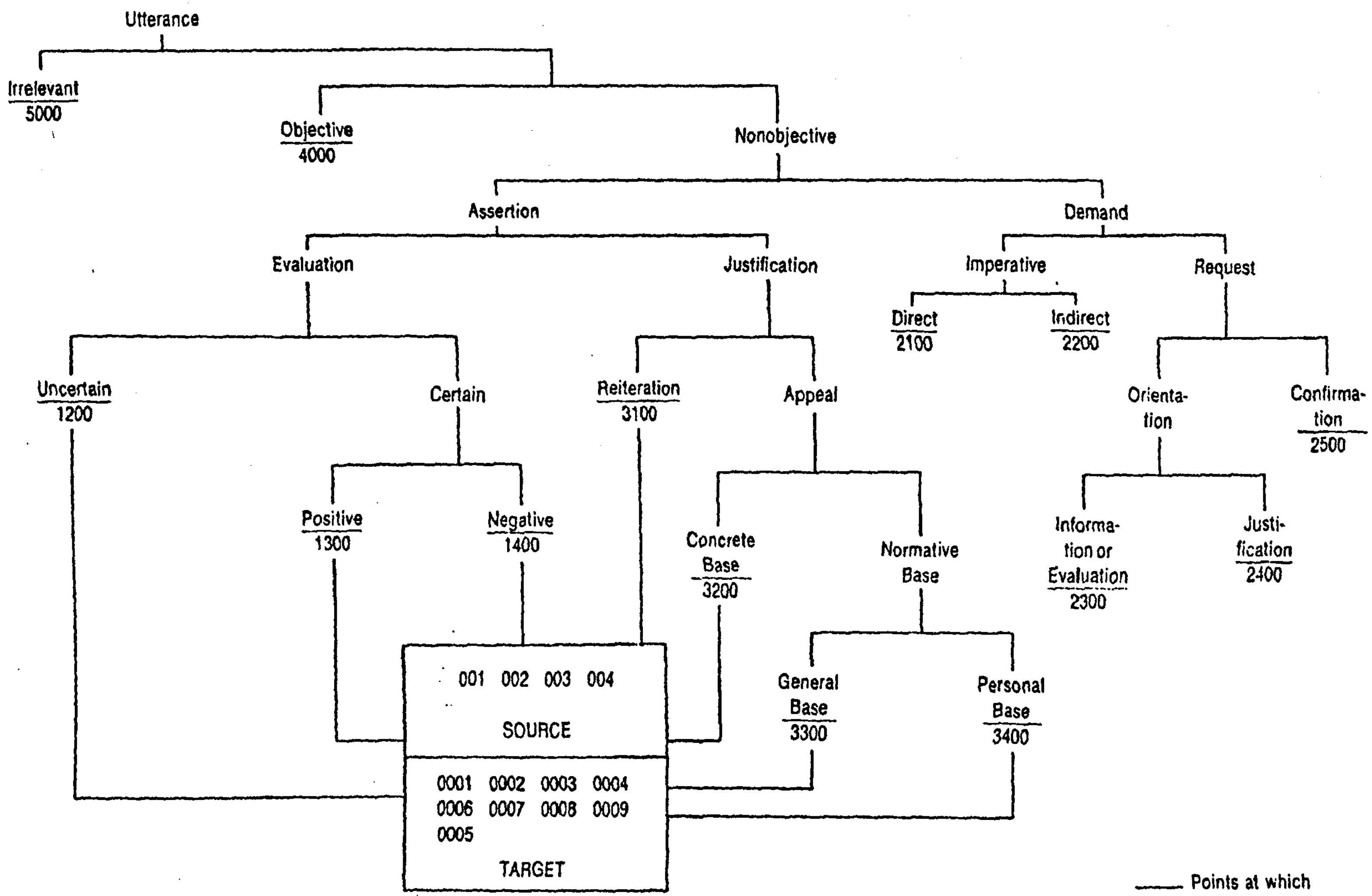
10 Disagrees, showing passive rejection and formality, withholds help

11 Shows tension and asks for help; withdraws out of field

12 Shows antagonism, deflating other's status and defending or asserting self

Legend:

a. Problems of orientation
b. Problems of evaluation
c. Problems of control
d. Problems of decision
e. Problems of tension-management
f. Problems of integration



Danziger's Category Model (Danziger, 1976)

Appendix 4.5 Category Framework Definitions and Exemplar

C1-PLANNING WORK

1-Structure project - How the project will be structured. Lifecycle parts - division of areas of responsibility prior to allocation.
"...We think that we should divide the whole project into smaller parts..."

2-Project requirements - What is required to complete the project.
"...Do you know about the level of detail in the requirement spec?"

3-Identification of tasks/Design- Identification of actual work which needs to be carried out to complete or as part of the project.
"...Interfacing with java is still required"

4-Allocation of tasks - Assign or volunteer to take on work/task
"...Why don't you guys look into the navigation...we will start looking at the client/server..."

5-Task value/Importance - Give value or importance to a particular task
"...Well, we figure that the nav. Alg. Will be the hardest part, do you agree?"

6-Prioritise tasks - State which task(s) are to be done first either because of importance or because of dependence with other tasks or they are quick/easy.
"...It's probably good to get things done quicker. To get a draft done."

7-Proj milestones/deadlines - When something is due.
"...The deadline for this document is Monday"

8-Completed work - When a task or part of a task or milestone is completed.
"...The password is now all set up and ready to go."

9-Proposal for work plan - A proposed way of working on the project as a whole.
"...What I'm trying to say is that the specification should be detailed enough to serve as a "coding plan"."

10-Request for work update - Asking for an update of where people are in their tasks.
"...email from EVERYONE telling me what you have done as far as implementation is concerned."

11-Work update given - Usually (but not restricted to) reply to #10 giving an update as to how far they are in their work.
"...have tried to make some sort of Navigation algorithm but haven't really succeeded that much..."

C2-PLANNING ADMIN

1-Meetings when - Discussion of when a meeting can take place.
"...Do you guys want to have a meeting later on this week?"

2-Meetings how (IRC Netmeeting...) - Discussion of 'where' a meeting can take place. What type of media will be used.
"...I'll send another message soon with details about where exactly to meet"

3-Meeting agreements - A definite agreement on a meeting has been made and recognised.
"...The meeting arrangements are fine!"

4-Sub group meetings - Evidence that sub-groups, either the Swedes or Americans as sub-groups or smaller numbers have met or discussed the project.
"...we here in Sweden had a little informal...meeting, where we talked a little about the project."

5-Plans/agenda for meeting - Suggestions/proposals about what is to be or should be discussed in a future meeting.
"...useful as a basis for future discussions."

6-Structuring of meeting - Current meeting not structured and discussion needs to be focussed. Suggestion that meeting needs to be structured.
"...Should we structure this meeting a bit"

7-Meeting log - Reminder that meetings need to be minuted logged. Reference to previous meetings which were logged.
"...Will you save transcripts of these meetings?"

8-Sub-Meeting where (physical) - How will people meet? Face to face, telephone, etc. (Poss. Similar to #2 - unless #2 is a sub-group meeting)
"...meet at GVSU or dial in from home"

9-Tutor Feedback/Intervention - Evidence/suggestion that tutor has given advice/feedback on project.
"...Team X, You need to make your documentation linked to your main project page."

10-Absent Members - Statement that a group member will or is absent from a meeting.
"...I won't be there..."

C3 - DECISIONS

1-Use of Equipment/language - Decision to use a particular piece of equipment for a task or a language for coding.
"...Ok, for software the client should have java..."

2-Use of method/format - Decision to use a particular method/format for working.
"...We think it should be a GUI interface that connects to the server and sends it a path in some sort of ..."

3-Work to begin - Decision that work should begin on a particular task.
"...we need to get to work right away on the specs so that we can get this project underway."

4-Seek confirmation on decision - A decision has been made and confirmation is requested.
"...ok. Networking client-server code in java?"

5-Request for vote on decision - A decision needs to be made and a vote is requested. Choices are given.
"...Now we vote: All in favor of changing the specs so that they are more specific about..."

6-Vote given - A vote is given on a decision to be made.
"...A little vote from K...So I say AYE to the waypoint thing."

C4 - ROLES

1-Show (recognise) leadership - Statement of being the leader. (Recognising that someone is the leader)
"...but that's my job as team leader."

2-Show technical knowledge - Showing technical competence by work produced or explanations given.
"...It can be solved easily with RMI using some init function called "GET-PICTURE" that returns an image"

3-Self-expressed expertise - Stating self knowledge or experience in a particular area(s).
"...We have taken classes in mechanics and signal-processing which we think could help us."

4-Colleague-expressed expertise - Statement made by a colleague of knowledge or experience in a particular area(s).
"...D is really the expert on the daemon"

5-Declare lack of knowledge - Statement showing inexperience or lack of knowledge in a particular area(s).
"...I dunno much about these java.util.Properties stuff"

6-Show reluctance to take on a task - Showing reluctance or inability to take on a task.
"...you can pretty much count me out..."

7-Show willingness to share work/ideas - Show willingness to share information, ideas, work, code etc. with others.
"...that I'll share now"

8-Show withholding of work/ideas - Withholding of information, ideas, work, code etc. from others.
"...I am experimenting with passwords because...there is only a password on the arch stuff...encrypted."

9-Ask for tutor advice or outside sources - Ask tutor or other sources for advice/help.
"...I will talk to E about the problems you are having and how to go about solving them."

10-Show conf/frustration at course admin - Show confusion or frustration at the way the course is run or at the tutors.
"...Have you guys received anymore information on what this project actually entails?"

C5 - CONFLICT

1-Initiating - Demonstrates initiation of conflict.
"...A little page? What are you getting at, K?"

2-Challenge - Demonstrates a challenge to the conflict. Not backing down.
"...So, are you trying to say that you don't like our page??"

3-Resolution of - Finding a resolution to the conflict.
...and still I think that if we talk to the other team and agree on what questions...

4-Reasoning - Give a reason for the initiation or challenge of conflict.
"...I was just trying to bring it up for debate?"

5-Misunderstanding - Showing a conflict (or possible conflict) being recognised as a misunderstanding.
"...misunderstanding about the time, too"

6-Avoid - Showing that conflict has been avoided.
"...should not be seen as anything more than that"

7-Suggest compromise - Suggestion for reaching a compromise. Further discussion or a vote may be required.
"...How about, if we try to reach a compromise?"

8-Cautious approach - Showing cautious approach to a possible or existing conflict.
"...I hope I didn't offend you (maybe you knew all of this before...)"

9-Dismissive - Dismissing a comment/concern/idea that someone has made or treating it as unimportant.
"...K: Why don't you and I argue that later...the others don't need to see the uglyness...."

10-Defuse situation - Attempt to defuse a situation where conflict has arisen or has the possibility to arise.
"...Hey everybody. Lighten up"

C6-SOCIAL/GET TO KNOW

1-Volunteering information - Volunteering personal/social information which may help others to get to know you.
"...For Valentine's day, P proposed to me, so it's official now - we're engaged!"

2-Asking for information - Requesting personal/social information which may help others to get to know you.
"...D...on your webpage? Brothers? Your Child? Boyfriend? I'm curious."

3-Initiate greeting/farewell/apology - Demonstrate initiation of greetings or apology. Use closing farewells.
"...Hello again"

4-Replying to greetings/info/apology - Reply to previous initiation of greetings or apology.
"...have fun skiing, E"

5-Validation that work is correct - Give validation and assurance that work produced is correct.
"...Looks good to me - especially the TeamX graphic!"

6-View/Id comm media/dist as obstacle - View email/IRC or distance as an obstacle in their communication.
"...My connection is too bad for the moment..."

7-Ignore comm media/distance - Ignore email/IRC or distance as an obstacle in their communication.
"...I'll "see" you guys on Tuesday."

8-Encouragement - Give encouragement that things are going well and/or that they will go well.
"...I'm sure this project will be great!!!"

9-Show gratitude - Show gratitude about help received from others.
"...Thank you, H, for helping!!"

C7 - HUMOUR

1-Initiate - Demonstrate initiation of humour.
"...E and H kept drinking while I tried to keep a serious attitude."

2-Respond - Reply to the initiation of humour.
"...You think the colleges would pay for us to fly down there?"

3-To defuse a situation - Use humour in helping to defuse a difficult situation such as conflict.
"...Way cool!!! Rock on E!!"

4-Local to country/area - Show humour which is local to area or country and possibly not understood by others.
"...Thought I should "draw my straw to the stack""

C8-GRAPHICAL EXPRESSIONS

1-Friendly/Greetings - Use graphical expressions as (or part of) a greeting or showing friendliness.
"... =D"

2-Defuse (poss.) conflict - Use graphical expressions in helping to defuse a difficult situation such as conflict.
"... :-)"

3-Confusion - Use graphical expressions to show confusion and/or lack of understanding.
"... ?!?!?"

4-Surprise - Use graphical expressions to show surprise.
"... what!!?? When!!!??!..."

5-Humour - Use graphical expressions as part of humour.
"... =D"

6-Emphasis of expression (CAPS/!!) - Use CAPS or !!!!! (more than one) to show emphasis.
"...M IS THE BOSS!!!"

7-Show disapproval/unhappiness - Use graphical expressions to show disapproval or unhappiness.
"... :("

C9 - IDEAS

1-Initiate - Demonstrate initiation of a general idea, not necessarily connected with a task.
"...It would be really nice if everyone could mail you URL's to their documents. That way everybody..."

2-Challenge - Demonstrates a challenge to the idea originally initiated.
"...We are not sure about motors being the hardest part. Why do you think it will be a problem?"

3-Request ideas/opinions - Shows a request for ideas or opinions.
"...What do you guys think?"

4-Offer advice/instructions/info - Giving of advice/information/instructions on how to achieve a particular task or where to get the information.
"...Check out http://www.java.....The java on-line docs are the best"

5-Critique - Giving critique of the idea. Not a challenge but putting the idea down as bad.
"...today was pretty ok, but maybe a bit unpersonal and chaotic"

6-Support idea - Showing support for the idea originally initiated.
"...good idea!"

7-Reply to request - Reply to the request of ideas/opinions.
"...So what you desired is possible, even though not with RMI..."

C10 - IDENTIFICATION

1-With whole group - Identification of self as part of the whole group/team.
"...we are a team right?"

2-With sub group - Identification of self as part of a sub-group/team.
"...we swedes"

3-As individual - Identification of self as an individual.
"...I, K had some personal thoughts about you people?"

C11 - TASK/WORK SPECIFIC

1-Suggest changes - Giving a suggestion/proposal of change to work that has been carried out.
"...Instead of a vector, which sounds complicated, how about an array?..."

2-Justify request/propose for change - Justification for the suggestion/proposal to change.
"...I can't read the text at home."

3-Propose (method) of work - Propose a particular way or method of working on a particular task.
"...Here are some more proposed parts for the specification."

4-Critique work - Giving critique of work that has been carried out. Not a challenge but putting the work down as bad.
"...This is in my opinion incorrect."

5-Verify/understanding - Verification that a suggestion or proposal has been understood correctly.
"...Ok, here is the summary: The client applet will have a picture that we get from the video..."

6-Challenge new proposal - Demonstrate a challenge to a new proposal.
"...Well...I suppose it's possible but probably not very useful."

7-Request clarification - Request clarification of how or why something within a task works.
"...What is summary and intro?"

8-Clarify tasks/work - Give clarification of how or why something within a task works.
"...Intro is like an overview of what the project is supposed to do and summary can sum things up"

9-Recognise problem - Recognise that there is a problem with the task or work carried or being carried out.
"...if the rate is lowered, the navigator can become ustable and totally loose control..."

10-Resolve problem - Show resolution to the recognised problem.
"...I rearranged the code to kill the socket and create an new one every time..."

11-Identify lack of resources - Identify a lack of resources such as computers...
"...had to sit and wait 2 hours for use of the equipment...."

12-Test planning or carried out - Discussion of testing being planned or being carried out.
"...T is going to write a test program..."

C12 - GOALS

1-Team goals - Demonstrate recognition or concern for team goals.
"...That counts for the bonus points listed in the revised grading scale!"

2-Personal goals - Demonstrate recognition or concern for individual/personal goals.
"...I want a good grade in this class"

Appendix 4.6 Reliability Tests

Contents of Appendix 4.6

Test 1	Master Copy	10	pages
	Reseacher's copy to code		
	IC1	10	pages
	Independent Coder's copy to code		
Test 2	Master Copy	9	pages
	IC1	8	pages
	Independent Coder 1's copy to code		
	IC2	9	pages
	Independent Coder 2's copy to code		
		46	pages

Master Copy - Test I


```
        Mon, 8 Feb 99 14:11:12 +0100
Received: from [redacted] ([148.61.162.37]:1083 "EHLO
[redacted]" ident: "root")
        by emberiza.its.uu.se with ESMTP id <55338-36328>;
        Mon, 8 Feb 1999 14:09:53 +0100
Received: from localhost ([redacted]) by [redacted]
        with SMTP (8.7.6/8.7.3) id VAA10966;
        Fri, 5 Feb 1999 21:01:18 -0500 (EST)
Date:   Fri, 5 Feb 1999 21:01:18 -0500 (EST)
From: [redacted]
To: [redacted]
Cc: [redacted]
Subject: arch design
In-Reply-To: <Pine.HPP.3.95.990123125436.10697A-
100000@[redacted]>
Message-Id: <Pine.HPP.3.95.990205205900.10962A-
100000@[redacted]>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
X-UIDL: 636
Status: U
```

5/2/99

MD

E153

9.4 3.3

Just to let you know, D[redacted] and I have begun to work on the arch design,
so if you want to see what we have, it is at:
www2.gvsu.edu/[redacted]/brio/arch

That is the directory that the html files are in. You can click on which
one you want to see.

Feedback before the meeting is welcome. 9.3

[redacted]

++

From ...
Receiv ... 43.2] by r
ESMTP
(SMT ... Feb 1999
Receiv ... with SMTP
v2.2);

Receiv ... Minsk.DoCS.
[130.2 ... 12) with
... Feb 1999

Receiv ... SunOS 4.1.
... ICU/DoCS i

Receiv ... DoCS.UU.SE
4.1.2) ... ICU/DoCS i

For Validation

T4-1999

E153

E154

I1

I5

Results

E153 - Master Copy

Total Coded Phrases - 3

IC-1

Matched phrases - 3

Differences - 0

E154 - Master Copy

Total Coded Phrases - 4

IC-1

Matched phrases - 4

Differences - 0

P5

337

Received: from [redacted] ([148.61.162.37]:1083 "EHLO brookie.csis.gvsu.edu" ident: "root")
by emberiza.its.uu.se with ESMTP id <18475-42992>;
Mon, 8 Feb 1999 14:09:51 +0100
Received: from localhost ([redacted]) by [redacted]
with SMTP (8.7.6/8.7.3) id AAA10830;
Sun, 7 Feb 1999 00:28:34 -0500 (EST)
Date: Sun, 7 Feb 1999 00:28:34 -0500 (EST)
From: "[redacted]
To: [redacted]
<[redacted]>,
h[redacted]
[redacted]m,
[redacted]
Subject: ATTN: SWEDEN BOYS!!

7/2/99

Message-Id: <Pine.HPP.3.95.990207002815.10786F-
100001@[redacted]

E154

MD

Mime-Version: 1.0
Content-Type: MULTIPART/MIXED;
BOUNDARY="2005587745-1804928587-918349760=:10913"
Content-Id: <Pine.HPP.3.95.990207002815.10786G@brookie.csis.gvsu.edu>
X-UIDL: 638
Status: U

Content-Type: TEXT/PLAIN; CHARSET=US-ASCII
Content-ID: <Pine.HPP.3.95.990207002815.10786H@brookie.csis.gvsu.edu>

[redacted]:

Here is your pizza - hope you like pepperoni!! 8.6 7.1

[redacted]: I included special cold germs on the side just for you!! :) 8.6 8.5

[redacted]

+++++++++++++++++++++++++++++++++++

From ???@??? Mon Feb 08 23:08:10 1999
Received: from venus.open.ac.uk [137.108.143.2] by mcs.open.ac.uk with ESMTP
(SMTPD32-4.06) id AAA0BAB03A4; Mon, 08 Feb 1999 18:19:12 +03d0
Received: from [redacted] by venus with SMTP Internet (MMTA v2.2);
Mon, 8 Feb 1999 18:19:04 +0000
Received: from Minsk.DoCS.UU.SE (runsten@Minsk.DoCS.UU.SE [130.238.9.30])
by [redacted]E (8.6.12/8.6.12) with SMTP id TAA20096
for <[redacted]>; Mon, 8 Feb 1999 19:18:48 +0100
Received: by Minsk.DoCS.UU.SE (Sun-4/630, SunOS 4.1.2)
with sendmail 5.61-bind 1.5+ida/ICU/DoCS id AA20189;
Mon, 8 Feb 99 19:18:46 +0100
Received: from [redacted]Minsk.DoCS.UU.SE (Sun-4/630, SunOS 4.1.2)
with sendmail 5.61-bind 1.5+ida/ICU/DoCS id AA20184;
Mon, 8 Feb 99 19:18:45 +0100

I1 - Jan 26, 1999

T meeting1_log.htm

Session Start: Tue Jan 26 14:56:23 1999
<S[redacted]> Hello again - 6.3
<S[redacted]> :) 8.1
<S[redacted]> Class didn't take as long as we thought — 6.1
<E[redacted]> Hi! You're back! - 6.3
<S[redacted]> All three of us are here now — 6.1
<H[redacted]> so did you get any interesting information? — 6.2
<S[redacted]> Well, we got a key to the lab where the whole thing will be set up — 6.4
<S[redacted]> Unfortunately, nothing much is set up
<E[redacted]> Ok.. We are three over here as well. Everybody's here! — 6.1
<S[redacted]> We also found out that the code for the camera will be available — 6.1
sometime soon
<E[redacted]> Ok. Good.
<S[redacted]> We read over your notes from your meeting — 5.1
<S[redacted]> We had a lot of similar thoughts
<S[redacted]> However, we were looking at your idea for the client page. We were
thinking of something a bit simpler...
*** K[redacted] has joined #brio 6.3
<K[redacted]> elo! - 6.3
<S[redacted]> Hi, K[redacted] :) - 8.1
6.3 — <K[redacted]> S[redacted]! =D — 8.1
<H[redacted]> What do you meen by simpler? — 5.2
<H[redacted]> How much simpler? — 8.3
<K[redacted]> ?!?!? What are you talkin about? — 6.2
<S[redacted]> Just a big picture of the board for the person to draw on — 9.1/1.3
<K[redacted]> =D — 8.2
<S[redacted]> and then some options for them to choose, like if it sends a movie — 9.1/1.3
back, or if they want to send java script...
<S[redacted]> That kind of thing
<K[redacted]> Huum.. oki
<S[redacted]> I can make a diagram and put it on the web a little later... — 9.1
<E[redacted]> Should we structure this meeting a bit (hey M[redacted] show your
leadership! :-). — 8.2 2.6 4.1
<S[redacted]> Ok!
<S[redacted]> :) — 8.2
* S[redacted] hits a gavel on the desk
<S[redacted]> I call this meeting to order — 4.1
<S[redacted]> Now, is there any new business that needs to be discussed?
* K[redacted] Juuumps to E[redacted] computer... . - - -- -- -- -- ------>
*** K[redacted] has quit IRC (Leaving)
<E[redacted]> We will follow your example, and use only one nick (mine). Maybe that — 2.6
makes things simpler.
<S[redacted]> Ok, that will help 8.6
* H[redacted] also makes a biiiiiggggg jump to E[redacted] comp...
*** H[redacted] has left #brio
<S[redacted]> We have looked into the client and server1 — 9.4
<S[redacted]> We found code that we think will work, so that part of it is pretty 1.8
much done
<E[redacted]> Ok. How much? Networking? Navigation? What parts? — 1.3
<S[redacted]> Well, just the part that connects the client and server — 1.2
<S[redacted]> We can't really do a whole lot more with that until the whole thing
is physically set up
<E[redacted]> Ok. Networking client-server code in java? — 3.4
<S[redacted]> yep
<E[redacted]> ok..
<E[redacted]> Have you guys discussed who is doing what — 1.4
<E[redacted]> ?
<S[redacted]> By the way, we are not real familiar with java, just so that you guys 4.5
know...
<S[redacted]> We have some ideas about how to divide it up between the two halves — 1.4
<E[redacted]> Oki.. we know some jave.. written two labs.. one bigger one
4.3

<E[redacted]> Ok
<E[redacted] We have also
<S[redacted]> Ok, what are your thoughts about how to divide it up? -9,3
<E[redacted] We think that we should divide the whole project into smaller parts.. 1,1
<S[redacted]> Like which parts?
<E[redacted] We mean really small parts.. that we could distribute.. among us and 1,1
along the way..
<E[redacted] What is your ideas on that issue? -9,3
<S[redacted]> Ok, well, we were thinking about dividing it into two major parts, -1,1
and then dividing those between the team halves
<S[redacted] We would still communicate ideas and things like that
<S[redacted]> but this way it would be easier to get the larger pieces done
<E[redacted] I don't think Carl and Lars will like that way of working (it didn't -5,2
sound that way anyway)...
<S[redacted]> Ok, so what smaller pieces were you thinking of?
<E[redacted]> There is a point in what you say (more effective since communication -5,4
is easier within a country :-), but the teamwork part sort of
disappears. -8,2
<S[redacted]> What smaller pieces did you mean? -9,3
<E[redacted] Ok. You already mentioned one: Client-server networking (which could be 1,1
split up further), Motor control, Camera code, Client code etc...
<S[redacted]> Ok, the camera code will be given to us.. -1,4
<S[redacted]> The motor control will be the hardest part.
<S[redacted]> How do you think we could divide that up? -9,3
<E[redacted] Ok. But we don't know how good the camera code will be, and it won't be -1,3
in java, so interfacing it with java will be another part.
<S[redacted]> Oh, we were under the impression that the camera code would be fully
functional...
<E[redacted]> Ok. We were told that it works to some extent, but might need -1,3
improvement. Interfacing with java is still required.
<S[redacted]> ok..we can look into that further when we get the actual code
<S[redacted]> How do you think we could divide the motor control part up? -9,3
<E[redacted]> ok.. thats great.. -9,3/1,3
<E[redacted] How about requirement specification? How should we go by writing that
(40% of marks this class!)... -1,5
<S[redacted] Hmm...what are your ideas for that? -9,3
<E[redacted] Even if it's important to distribute work, writing the specs will make -9,1
that job easier. -3,3
<S[redacted]> Ok, then lets work on that now, and see what we come up with
<E[redacted]> One thing we need to do is find out certain facts about hard/software. -1,3
<E[redacted]> This will let us make certain decisions for the specification.
<S[redacted]> Ok, for software the client should have a java - capable web browser -3,1
<S[redacted]> and also, a movie player if they want the movie returned
<E[redacted]> Yes.
<S[redacted]> What are your thoughts about hardware requirements? -9,3/1,3
<E[redacted]> Capture frequency (roughly!) of the camera, motor data (roughly!)... -1,1
Things we need to know to decide on "algorithms" to use.
<S[redacted]> the motor part is going to be the hardest part -1,5
<S[redacted]> the capture frequency of the camera will be known when it is set up.
It should be set up soon -1,5
<E[redacted]> We are not sure about motors beeing the hardest part. Why do you think -9,3
it will be a problem?
<S[redacted]> Because we don't know how to write code that will turn the motor... -4,5
do you guys know how to do that?
<E[redacted]> Umm.. well.. I think there is some info on that on the main web.. Its -9,4
basically just setting up a port an writing to it..
<S[redacted]> what do you think will be the hardest part -9,3
<E[redacted] ..We think, that the navigational part of the code will cause much -1,5
headache.. =
<E[redacted]> =D -8,1
<S[redacted]> I think that's the part we were talking about too. We should have
been more specific...sorry 6,3
<E[redacted]> ..cause of the "matematical-mechanical" nature of it..

<E[redacted]> oki.. =) np -8.1
<S[redacted]> We are going to set up a lunch meeting with an experienced robotics person
<S[redacted]> Hopefully, we can get some ideas about that from him 4.9
<S[redacted]> (Dyana has connections...) :) -8.1
<E[redacted]> Ok. We have taken classes in mechanics and signal-processing which we think could help us. As this will probably end up being some sort of "regulator", heavy math is probably awaiting... -4.3
<S[redacted]> Hopefully no calculus....I HATED that class!! -8.6
<E[redacted]> Hopefully we'll get down to having as few calculations as possible, right? -6.8
<S[redacted]> Yep
<S[redacted]> Why don't you guys look into the navigation part of it, and we will start looking at the client/server and the web interface -1.4/3.3
<S[redacted]> We can compare notes at our next meeting -1.9
<E[redacted]> Ok. We could start looking into it. Do you know about the level of detail in the requirement spec? -1.2/9.3
<S[redacted]> No, but I can email Carl and ask him for more information about them -4.9
<S[redacted]> Also, we need an account for the linux boxes that the game will be set up on. We were thinking about a group account that will just be called "Team[redacted]" Is that ok? -3.4 1.3
<E[redacted]> Ok. But we think that it would be great if we could get started with what we can do right now... -3.3
<S[redacted]> Ok, what are you going to work on
<E[redacted]> ...maybe start writing on different parts of a draft to a spec or something. -1.9
<E[redacted]> Team4 is ok. Where will this account be? -9.3
<S[redacted]> Don't know where the account will be.. I'll let you know as soon as I get a reply from Carl -4.9
<S[redacted]> How about each team half can work on the specs and we will email them to each other by Monday? -1.7 -1.9
<S[redacted]> then we can look them over and compare them at the next meeting
<E[redacted]> Ok. One more thing. It would be great to have some sort of bulletin board with links to info and some sort of event list (calendar)... -9.1
<S[redacted]> Ok. I can put that on the page...
<S[redacted]> Everyone can email me the links and ideas and stuff like that
<E[redacted]> Will you save transcripts of these meetings? -2.7
<S[redacted]> I think we are supposed to. I tried to log this, but I don't know if it worked 1.2 2.7
<S[redacted]> Ok, I just checked, and the log appears to have worked -6.5
<E[redacted]> We have some of it (almost everything). We'll mail it to you. Links to these would be great to have as well. 2.7
<E[redacted]> Ok...
<S[redacted]> Ok, I'll work on that
<S[redacted]> To sum up what we will be doing: -9.3/3.4
<E[redacted]> So, about the spec. What should we do? Both halves write a complete draft, then compare, discuss and merge?
<S[redacted]> Both teams will work on the specs (rough drafts) -1.9
<S[redacted]> You guys start thinking about the navigator (get some ideas) since you have some experience with that -4.4 1.4
<S[redacted]> We will look into the client/server and the actual web interface. We will also bug Carl about the code.
<S[redacted]> I will email carl and get more info about the specs and get working on a bulletin board
<S[redacted]> Does that work for everyone?
<E[redacted]> We think so. Give us a couple of minutes to discuss and think of things we have forgotten to mention, ok?
<S[redacted]> ok
<E[redacted]> Ok. We can't think of anything special.
<S[redacted]> Ok, if you do, just email it, or put it on a page and send me the URL. -9.1
<E[redacted]> For your information. E[redacted] will be gone saturday to thursday (skiing!!!) next week.
6.1 8.6
<S[redacted]> Ok

<S[redacted]> Can H[redacted]k and K[redacted] still meet on Tuesday at 2:30(8:30)? -2.1
<E[redacted]> Ok.
<E[redacted]> Same time, same bat-channel! -7.1
<E[redacted]> =D 8.5
<S[redacted]> Alright. Then, have fun skiing, E[redacted], and we'll see K[redacted] and H[redacted] next Tuesday -6.7
<S[redacted]> :) -8.1
<E[redacted]> Okii.. well well.. Is this over now? Are you leaving us here??!?!?1 -2.6 -8.6
<E[redacted]> =D -8.1
<S[redacted]> Well, actually, D[redacted]a and J[redacted] had to leave right at four, so I am alone here :(-8.7 -2.10
<S[redacted]> Shall I do my leadership thing and officially adjourn this meeting? :) -4.1/2.6 -8.1
<E[redacted]> Ok. If thers's anything we'd like to say, we'll mail everybody about it. More communication is better than less! -9.1
<S[redacted]> I agree -9.6
* Sh[redacted] gets out the gavel
<E[redacted]> Please, do your thing, S[redacted]! -4.4
<S[redacted]> meeting adjourned. We'll meet again next week, same time, same place -2.1 -2.2
* Sh[redacted] hits the desk with the gavel
<E[redacted]> Party time!
<S[redacted]> Bye! -6.3
<E[redacted]> Bye. -6.3
*** Disconnected

Results

I1-Master Copy

Total Coded Phrases.
P.1-35
P.2-34
P.3-34
P.4-20
Total 123

IC-1

Matched phrases-116

Differences.-21

I5 - Feb16 1999

T[redacted] meeting5_log.htm

Session Start: Tue Feb 16 15:17:42 1999
*** Now talking in #brio
<S[redacted]> Ok.
<D[redacted]> I am working on the Position Daemon, it is not very complicated. 1.4 6.8
<K[redacted]> Im talking with some REAL guru's on RMI — 4.9
<K[redacted]> =) — 8.1
<J[redacted]> I'm getting the client running — 1.4
<E[redacted]> Ok. Cool. Are you experiencing any troubles with Java? — 9.3
<J[redacted]> not as yet
<S[redacted]> So, when am I going to get everyone's pictures? — 6.2
<D[redacted]> Shell: Did I already give you that stuff? — 6.2
<S[redacted]> Yes and no.
<S[redacted]> I need to know what is public/private and the variable names. 4.5
<S[redacted]> I already have the rest drawn up, for the most part. — 1.11
<D[redacted]> We will talk tomorrow, OK? 2.1
<S[redacted]> ok
<J[redacted]> I will get it to you by Thurs evening — 1.7
<S[redacted]> Jay: by 3:00? — 1.7
<J[redacted]> ok
<D[redacted]> Should be meet again before this is due ?? Just so everyone can look things over and make any comments? 2.1
<S[redacted]> Everyone also needs to let me know what parts communicate with each other... — 4.1 — 1.4
<S[redacted]> Well, that was the point of today's meeting...but I don't have all the stuff yet from _certain people_ 2.5
<D[redacted]> Sh[redacted]: new deadlines ?? what are they?? — 6.2
<S[redacted]> Ok new deadline: 8.6
<S[redacted]> I want EVERYONE'S pics and comments and all of that stuff to me NO LATER THAN 3:00 thursday — 1.7
<K[redacted]> Shell: GOT that! 8.6
<S[redacted]> At 3:01, if I don't have everything, someone will be in BIG trouble 8.6 — 7.3
<K[redacted]> =) — 8.2
<J[redacted]> aye aye chief — 7.3
<S[redacted]> Any questions?
<D[redacted]> what about the test programs?? — 11.12
<E[redacted]> How about collaboration diagrams? — 9.1/1.3
<S[redacted]> Everything! — 4.1
<S[redacted]> Test programs should be done by then, too...I would think... 11.12 1.7
<E[redacted]> If you want, I can read up a bit on those and try to give a similar description... Do you want me to do that? — 9.1/1.4
<S[redacted]> Yes, that would be great.
<S[redacted]> I looked at the page that Carl has a link to, and there is a really good description of coll. diagrams there. — 9.4
<K[redacted]> Ill focus on the specs first. — 1.6
<E[redacted]> Hey... Test programs as well. That's too much for me. I have a giant deadline in another class this friday. Can't we say Sunday for the test programs? 8.6 11.12 — 4.6 1.7
<E[redacted]> Ok. Got that about collaborations and Carl.
<S[redacted]> Only on ONE condition: They are in HTML format and ready to be put right on the web. Remember that the specs are due Monday. 9.4 — 1.7
<S[redacted]> For the test progs: do we just need to have a description of what, why, how, and then the code? 1.2
<E[redacted]> Ok. You want the code for the test programs html:ed. Fair enough... I'll do that. — 1.4 11.12
<J[redacted]> that's what Carl's page says — 4.9
<E[redacted]> I suppose so. 8.6
<S[redacted]> Ok, and if ANYONE doesn't have their test progs to me, in HTML format, by Sunday at 4:00 US time, they will feel my wrath - even if I have to fly to Sweden! Understood? 11.12 — 1.7 — 4.1/7.1
<E[redacted]> I'll flee to Norway this Sunday... :) 8.5
<S[redacted]> I'll hunt you down! :)

7.2 8.5 7.2

-1.7
<S[redacted]> By Thurs, when all the class/coll diagram stuff is due, I also -4.1
need emails about what parts communicate, so you guys better be -1.9
talking to each other, ok?
<E[redacted]> Sure thing!
<S[redacted]> Everyone else? Do you have all this? -5.1
<E[redacted]> Dy[redacted]: I'd like to communicate with you, ok? :) -8.2
<J[redacted]> yes ma'am -7.3
<S[redacted]> H[redacted]k? K[redacted]? Dy? -5.1
<E[redacted]> D[redacted]: It's about positioning and stuff...
<D[redacted]> E[redacted] ok
<K[redacted]> Always!
<J[redacted]> I have to leave in a few minutes....when the next meeting?? -2.1
<S[redacted]> Good question...
<S[redacted]> We can't meet until I have all this stuff done... -1.7/2.1
<D[redacted]> ok
<K[redacted]> =) 8.1
<D[redacted]> Do you guys want me to call you on the phone? -2.8
<S[redacted]> We have to meet either Saturday or Sunday -2.1
<J[redacted]> I vote for Sunday -2.1
<D[redacted]> Sunday -2.1
<K[redacted]> E[redacted] would.. but I can go with Irc -2.2
<K[redacted]> -->d[redacted] 8.5
7.1
<E[redacted]> Sure D[redacted]! :) Call us and have a cheap transatlantic chat! :) -8.5
<D[redacted]> I just thought it would be different -6.1
<D[redacted]> I can call for free
2.8
<S[redacted]> D[redacted]: Let's call them Friday! :) 8.1
<K[redacted]> COOOL! -8.6
<E[redacted]> In that case... Suree!
<K[redacted]> wowoow
<D[redacted]> what is you phone number?? -6.2
<S[redacted]> Dy: are you going to call from work? -6.2
<D[redacted]> no
<J[redacted]> So when is the next meeting> -2.1
<S[redacted]> Can I be there too, then? :) -8.1
<E[redacted]> Mine is: +46(0)18 511581 -6.4
<D[redacted]> from Norm's work
<S[redacted]> Can I be there anyway? :) -6.2 8.1
<E[redacted]> Next meeting, S[redacted]? -2.1
<D[redacted]> I have never called another country if it doesn't work we
<S[redacted]> Saturday or Sunday? -2.1
<D[redacted]> need to have a back up plan -9.1
<J[redacted]> when is the next meeting....when is the next meeting....when is the
next meeting -2.1/5.1
<S[redacted]> email them..and let them know
* S[redacted] says "hold on Jason! We're working on it!" -5.2 4.1
* S[redacted] says "Saturday or Sunday, people?" 2.1
<H[redacted]> Sunday -2.1
<D[redacted]> Sunday -2.1
<J[redacted]> Sunday -2.1
<S[redacted]> Ok...how about 1:30? -2.1
<J[redacted]> ok -2.3
<H[redacted]> Ok -2.3
9.4
<E[redacted]> Dy: To call Sweden from where you are, I think that you dial:
0114618511581
<S[redacted]> which one?
<D[redacted]> Is it ok if i can't make it Sunday? -2.10
<S[redacted]> You voted for Sunday!! -5.1
<S[redacted]> What about Saturday morning? -2.1
<S[redacted]> Early...like 8:00...
<D[redacted]> I am supposed to be at my parents -6.1
6.6
<D[redacted]> I know but i was thinking later, I forgot about the time thing
<K[redacted]> I say AYE so sunDAY -2.3
<K[redacted]> to

<E[redacted]> Sunday is best for me 6.1 2.7
<S[redacted]> Ok, then, D[redacted] will have to miss the meeting..
<D[redacted]> I can just read the meeting log, but you guys can't talk about me -7.1
<S[redacted]> D[redacted]: I edit the log. :) -7.2 8.5
<J[redacted]> would we do that??-7.2
<D[redacted]> I know, I still do not want you to talk about me ! -7.1
<S[redacted]> I won't...It's those Sweden boys to worry about!! :) 8.5 7.2
<s[redacted]> i wont
<D[redacted]> E[redacted] and K[redacted]e are you by the phone now?? -6.2
<E[redacted]> No.
<H[redacted]> You can call me on my mobile phone
<D[redacted]> what time should i call you, it has to be before 5:30/US time -2.1/2.8
<J[redacted]> ok...i have to go now..... 6.3
<S[redacted]> bye J[redacted] -6.3
<D[redacted]> See Ya 6.3
<S[redacted]> That shouldn't be a prob: that's 11:30 Sweden time! 2.1
<H[redacted]> bye J[redacted] -6.3
<S[redacted]> What day are we calling? -6.2
<E[redacted]> By J[redacted]! 6.3
*** J[redacted] has left #brio
<D[redacted]> I was going to call today -2.8/2.1
<S[redacted]> Today/?
<D[redacted]> we can call friday too -2.8/2.1
<S[redacted]> What time friday?
<S[redacted]> What time today? 2.8/2.1
<D[redacted]> before 5:30
<S[redacted]> Hmm....
<S[redacted]> Can you do a conference call, and call me too? -6.2/2.8
<D[redacted]> Smith Barney closes at 5:30
<D[redacted]> I can try
<S[redacted]> Ok. :) -8.1
<S[redacted]> You have to wait until we get off of here, though...
<S[redacted]> yep.
<E[redacted]> And you'll have to wait for us to get home.
<D[redacted]> E[redacted] and K[redacted]e what time? 2.1
<S[redacted]> All of you go to one person's house...-9.1/4.1
<S[redacted]> D[redacted]: what time do you work on Fri? -6.2
<D[redacted]> I will come home after the test in 462 -6.4
<S[redacted]> Hmm...I have class until 4... -6.1
<S[redacted]> How about we try the conference call thing? -9.1
<D[redacted]> just get here before 5:30 -2.4
<K[redacted]> Hello.. now we've decided on time and place.. my place 10.40 2.4
<S[redacted]> I was supposed to bring K[redacted], remember?
<D[redacted]> that's ok
<S[redacted]> But, I think she has a meeting until 5...
<S[redacted]> I can double check
<S[redacted]> Kalle: today?
<D[redacted]> so 4:40/US time is that right -2.1
<D[redacted]> at 0114618511581
<E[redacted]> To get to Kalle: 0114618512632 -9.4
<S[redacted]> Or, you can just keep them on the phone until I get there on Friday!! :) -8.5 7.1
<S[redacted]> :) -8.5
<E[redacted]> Not the number you mentioned. That will get you to my sleeping girlfriend. That could be fun, but maybe not... :) -6.1 -8.5 7.2
<D[redacted]> you are 6 hours ahead, right? -6.2
<K[redacted]> correct
<K[redacted]> We have to go now if we should make it -2.6
<D[redacted]> ok i will call you at 10:40 and M[redacted] I will try to connect you too -2.4
<D[redacted]> Shell: stay off the phone
<S[redacted]> Ok. call me at least to let me know if it didn't work, ok? -9.1
<S[redacted]> I will. :) 8.1

<H[redacted]> Ok bye then -6.3
<E[redacted]> Talk to you later then! -6.3
<D[redacted]> Bye -6.3
<S[redacted]> bye - 6.3
*** D[redacted] has left #brio
*** H[redacted] has left #brio
*** Disconnected
Session Close: Tue Feb 16 15:55:00 1999

Results

I5 - Master Copy

Total phrases Coded -
P.1 - 50
P.2 - 49
P.3 - 46
P4 - 4
Total - 149

IC-1.
matched phrases - 139.5
Differences. - 54

Final Results

	mc	Match	Diff
E153	3	3	0
E154	4	4	0
I1	123	116	21
I5	149	139.5	54
Total	279	262.5	75
%		94.1%	26.9%
Non-difference			73.1%

Test 1 - IC1

(9.4)

Deduct -0

Mon, 8 Feb 99 14:11:12 +0100
Received: from [redacted] edu ([148.61.162.37]:1083 "EHLO [redacted] u.edu" ident: "root")
by emberiza.its.uu.se with ESMTP id <55338-36328>;
Mon, 8 Feb 1999 14:09:53 +0100
Received: from localhost ([redacted]) by [redacted] du
with SMTP (8.7.6/8.7.3) id VAA10966;
Fri, 5 Feb 1999 21:01:18 -0500 (EST)
Date: Fri, 5 Feb 1999 21:01:18 -0500 (EST)
From: [redacted] u>
To: H[redacted]
Cc: i[redacted],
r[redacted]
Subject: arch design
In-Reply-To: <Pine.HPP.3.95.990123125436.10697A-100000@b[redacted] edu>
Message-Id: <Pine.HPP.3.95.990205205900.10962A-100000@b[redacted] du>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
X-UIDL: 636
Status: U

5/2/99

E153

MD

Just to let you know, D[redacted] and I have begun to work on the arch design,
so if you want to see what we have, it is at:
www2.gvsu.edu/~[redacted]/brio/arch

3.3

9.4

That is the directory that the html files are in. You can click on which
one you want to see.

Feedback before the meeting is welcome. 9.3

M[redacted]

++ matched phrases - 3

Differences - 0

From ???@???/Mon Feb 08 23:02:29 1999
Received: from venus.open.ac.uk [137.108.143.2] by mcs.open.ac.uk with ESMTP
(SMTPD32-4.06) id A283861C0292; Mon, 08 Feb 1999 13:11:40 +03d0
Received: from [redacted]E by venus with SMTP Internet (MMTA v2.2);
Mon, 8 Feb 1999 13:11:32 +0000
Received: from Minsk.DoCS.UU.SE (runsten@Minsk.DoCS.UU.SE [130.238.9.30])
by [redacted]SE (8.6.12/8.6.12) with SMTP id OAA14620
for <M[redacted]ac.uk>; Mon, 8 Feb 1999 14:11:27 +0100
Received: by Minsk.DoCS.UU.SE (Sun-4/630, SunOS 4.1.2)
with sendmail 5.61-bind 1.5+ida/ICU/DoCS id AA16069;
Mon, 8 Feb 99 14:11:21 +0100
Received: from columba.its.uu.se by Minsk.DoCS.UU.SE (Sun-4/630, SunOS 4.1.2)
with sendmail 5.61-bind 1.5+ida/ICU/DoCS id AA16017;
Mon, 8 Feb 99 14:10:58 +0100

05
347

Received: from b[redacted]du ([148.61.162.37]:1083 "EHLO b[redacted]su.edu" ident: "root") Deduct -0
by emberiza.its.uu.se with ESMTP id <18475-42992>;
Mon, 8 Feb 1999 14:09:51 +0100
Received: from localhost (doodm@localhost) by [redacted]du
with SMTP (8.7.6/8.7.3) id AAA10830;
Sun, 7 Feb 1999 00:28:34 -0500 (EST)
Date: Sun, 7 Feb 1999 00:28:34 -0500 (EST)
From: "[redacted]>
To: d[redacted]k
<[redacted],
h[redacted],
j[redacted],
[redacted]SE
Subject: ATTN: SWEDEN BOYS!!
E154
Message-Id: <Pine.HPP.3.95.990207002815.10786F-100001[redacted]u> 7/2/99
Mime-Version: 1.0
Content-Type: MULTIPART/MIXED;
BOUNDARY="2005587745-1804928587-918349760=:10913"
Content-Id: <Pine.HPP.3.95.990207002815.10786G@brookie.csis.gvsu.edu> MD
X-UIDL: 638
Status: U

Content-Type: TEXT/PLAIN; CHARSET=US-ASCII
Content-ID: <Pine.HPP.3.95.990207002815.10786H@brookie.csis.gvsu.edu>

[redacted]: 8.6

7.1 Here is your pizza - hope you like pepperoni!! 8.6

[redacted]: I included special cold germs on the side just for you!! :) 8.5

M[redacted]

matched phrases-4 Differences-0

+++++++++++++++++++++++++++++++++++

From ???@??? Mon Feb 08 23:08:10 1999
Received: from venus.open.ac.uk [137.108.143.2] by mcs.open.ac.uk with ESMTP
(SMTPD32-4.06) id AAA0BAB03A4; Mon, 08 Feb 1999 18:19:12 +03d0
Received: from R[redacted] by venus with SMTP Internet (MMTA v2.2);
Mon, 8 Feb 1999 18:19:04 +0000
Received: from Minsk.DoCS.UU.SE (runsten@Minsk.DoCS.UU.SE [130.238.9.30])
by R[redacted]E (8.6.12/8.6.12) with SMTP id TAA20096
for <[redacted]uk>; Mon, 8 Feb 1999 19:18:48 +0100
Received: by Minsk.DoCS.UU.SE (Sun-4/630, SunOS 4.1.2)
with sendmail 5.61-bind 1.5+ida/ICU/DoCS id AA20189;
Mon, 8 Feb 99 19:18:46 +0100
Received: from R[redacted]by Minsk.DoCS.UU.SE (Sun-4/630, SunOS 4.1.2)
with sendmail 5.61-bind 1.5+ida/ICU/DoCS id AA20184;
Mon, 8 Feb 99 19:18:45 +0100

I1 - Jan 26, 1999

Dotuct -5

T[redacted] meeting1_log.htm

Session Start: Tue Jan 26 14:56:23 1999
<S[redacted]> Hello again 6.3 ✓
<S[redacted]> :) 8.1 ✓
<S[redacted]> Class didn't take as long as we thought 6.1 ✓
<E[redacted]> Hi! You're back! 6.3 ✓
<S[redacted]> All three of us are here now 6.1 ✓
<H[redacted]> so did you get any interesting information? 6.2 ✓
<S[redacted]> Well, we got a key to the lab where the whole thing will be set up 6.1 agreed opts
<S[redacted]> Unfortunately, nothing much is set up
<E[redacted]> Ok.. We are three over here as well. Everybody's here! 6.1 ✓
<S[redacted]> We also found out that the code for the camera will be available sometime soon 6.1 ✓
<E[redacted]> Ok. Good.
<S[redacted]> We read over your notes from your meeting
<S[redacted]> We had a lot of similar thoughts 5.1 ✓
<S[redacted]> However, we were looking at your idea for the client page. We were thinking of something a bit simpler...
*** K[redacted] has joined #brio 6.2 #1
<K[redacted]> elo 6.2 #1
<S[redacted]> Hi, Kalle :) 8.1 ✓
6.3 <K[redacted]> Shell! =D 8.1 ✓
<H[redacted]> What do you meen by simpler?
<H[redacted]> How much simpler? 5.2 ✓
8.3 ✓ <K[redacted]> ?!?!? What are you talkin about? 6.2 ✓
<S[redacted]> Just a big picture of the board for the person to draw on 9.4 / 1.3 ✓ agreed opts.
<K[redacted]> =D 8.2
<S[redacted]> and then some options for them to choose, like if it sends a movie back, or if they want to send java script... 9.4 / 1.3 ✓ agreed opt
<S[redacted]> That kind of thing 9.6 agreed opts.
<K[redacted]> Huum.. oki
<S[redacted]> I can make a diagram and put it on the web a little later... 9.1 ✓
<E[redacted]> Should we structure this meeting a bit (hey M[redacted] show your leadership! :-)... 8.2 ✓ 2.6 ✓ 4.1 ✓
<S[redacted]> Ok!
<S[redacted]> :) 8.2 ✓
* S[redacted] hits a gavel on the desk 4.1 ✓
<S[redacted]> I call this meeting to order
<S[redacted]> Now, is there any new business that needs to be discussed?
* K[redacted] Juuumps to E[redacted]s computer... . - - - -- - -- -- ------>
*** K[redacted] has quit IRC (Leaving)
<E[redacted]> We will follow your example, and use only one nick (mine). Maybe that makes things simpler. 2.6 ✓
<S[redacted]> Ok, that will help 8.6 #1
* H[redacted]k also makes a biiiiiggggg jump to E[redacted] comp...
*** H[redacted]k has left #brio
<S[redacted]> We have looked into the client and server1 9.4 ✓
<S[redacted]> We found code that we think will work, so that part of it is pretty much done 1.8 #1
<E[redacted]> Ok. How much? Networking? Navigation? What parts? 1.3 ✓
<S[redacted]> Well, just the part that connects the client and server
<S[redacted]> We can't really do a whole lot more with that until the whole thing is physically set up 1.2 ✓
<E[redacted]> Ok. Networking client-server code in java? 3.4 ✓
<S[redacted]> yep
<E[redacted]> ok..
<E[redacted]> Have you guys discussed who is doing what_ 1.4 ✓
<E[redacted]> ?
<S[redacted]> By the way, we are not real familiar with java, just so that you guys know... 4.5 ✓
<S[redacted]> We have some ideas about how to divide it up between the two halves 1.4 ✓
<E[redacted]> Oki.. we know some jave.. written two labs.. one bigger one

4.3 ✓

Page Difference - 9

<E[redacted]> Ok
<E[redacted]> We have also
<S[redacted]> Ok, what are your thoughts about how to divide it up? 9.3
<E[redacted]> We think that we should divide the whole project into smaller parts.. 1.1
<S[redacted]> Like which parts?
<E[redacted]> We mean really small parts.. that we could distribute.. among us and along the way.. 1.1
<E[redacted]> What is your ideas on that issue? 9.3
<S[redacted]> Ok, well, we were thinking about dividing it into two major parts, and then dividing those between the team halves 1.4 - agreed opts.
<S[redacted]> We would still communicate ideas and things like that
<S[redacted]> but this way it would be easier to get the larger pieces done
<E[redacted]> I don't think Carl and Lars will like that way of working (it didn't sound that way anyway)... 5.2
<S[redacted]> Ok, so what smaller pieces were you thinking of?
<E[redacted]> There is a point in what you say (more effective since communication is easier within a country :-), but the teamwork part sort of disappears. SB 5.4 agreed opts. 8.2
<S[redacted]> What smaller pieces did you mean? 9.3
<E[redacted]> Ok. You already mentioned one: Client-server networking (which could be split up further), Motor control, Camera code, Client code etc... 1.1
<S[redacted]> Ok, the camera code will be given to us. 1.1 - agreed opts
<S[redacted]> The motor control will be the hardest part
<S[redacted]> How do you think we could divide that up? 9.3
<E[redacted]> Ok. But we don't know how good the camera code will be, and it won't be in java, so interfacing it with java will be another part. 1.3
<S[redacted]> Oh, we were under the impression that the camera code would be fully functional...
<E[redacted]> Ok. We were told that it works to some extent, but might need improvement. Interfacing with java is still required. 1.3
<S[redacted]> ok..we can look into that further when we get the actual code
<S[redacted]> How do you think we could divide the motor control part up? 9.3
<E[redacted]> ok.. thats great.. 9.3/1.3
<E[redacted]> How about requirement specification? How should we go by writing that (40% of marks this class!)... 1.5
<S[redacted]> Hmm...what are your ideas for that? 9.3 agreed opts.
<E[redacted]> Even if it's important to distribute work, writing the specs will make that job easier. 9.4 3.3
<S[redacted]> Ok, then lets work on that now, and see what we come up with
<E[redacted]> One thing we need to do is find out certain facts about hard/software. 1.3
<E[redacted]> This will let us make certain decisions for the specification.
<S[redacted]> Ok, for software the client should have a java - capable web browser 3.1
<S[redacted]> and also, a movie player if they want the movie returned
<E[redacted]> Yes. 9.3/1.3
<S[redacted]> What are your thoughts about hardware requirements?
<E[redacted]> Capture frequency (roughly!) of the camera, motor data (roughly!)... Things we need to know to decide on "algorithms" to use. 1.1
<S[redacted]> the motor part is going to be the hardest part
<S[redacted]> the capture frequency of the camera will be known when it is set up. It should be set up soon 1.5
1.5 <E[redacted]> We are not sure about motors beeing the hardest part. Why do you think it will be a problem? 9.3
<S[redacted]> Because we don't know how to write code that will turn the motor... do you guys know how to do that? 4.5
<E[redacted]> Umm.. well.. I think there is some info on that on the main web.. Its basically just setting up a port an writing to it.. 9.4
<S[redacted]> what do you think will be the hardest part 9.3
<E[redacted]> ..We think, that the navigational part of the code will cause much headache.. 1.5
<E[redacted]> =D 8.1
<S[redacted]> I think that's the part we were talking about too. We should have been more specific...sorry SB 6.3 - agreed opts
<E[redacted]> ..cause of the "matematical-mechanical" nature of it..

Page - Differences 5

Deduct -2

8.1

<E[redacted]> oki.. =) np
<S[redacted]> We are going to set up a lunch meeting with an experienced robotics person
<S[redacted]> Hopefully, we can get some ideas about that from him 4.9
<S[redacted]> (Dyana has connections...) :) 8.1
<E[redacted]> Ok. We have taken classes in mechanics and signal-processing which we think could help us. As this will probably end up being some sort of "regulator", heavy math is probably awaiting... 4.3
<S[redacted]> Hopefully no calculus...I HATED that class!!
<E[redacted]> Hopefully we'll get down to having as few calculations as possible, right? 6.8
8.6
<S[redacted]> Yep
<S[redacted]> Why don't you guys look into the navigation part of it, and we will start looking at the client/server and the web interface 4.4 / 3.3 - agreed opts
<S[redacted]> We can compare notes at our next meeting 1.9
<E[redacted]> Ok. We could start looking into it. Do you know about the level of detail in the requirement spec? 1.2 / 9.3
<S[redacted]> No, but I can email Carl and ask him for more information about them 4.9
<S[redacted]> Also, we need an account for the linux boxes that the game will be set up on. We were thinking about a group account that will just be called "Team4" Is that ok? 1.3
5B 3.4 - agreed opts
<E[redacted]> Ok. But we think that it would be great if we could get started with what we can do right now... 3.3
<S[redacted]> Ok, what are you going to work on
<E[redacted]> ...maybe start writing on different parts of a draft to a spec or something. 1.9
<E[redacted]> Team4 is ok. Where will this account be? 9.3 -1
<S[redacted]> Don't know where the account will be...I'll let you know as soon as I get a reply from Carl 4.9
<S[redacted]> How about each team half can work on the specs and we will email them to each other by Monday? 1.7 1.9
<S[redacted]> then we can look them over and compare them at the next meeting
<E[redacted]> Ok. One more thing. It would be great to have some sort of bulletin board with links to info and some sort of event list (calendar)... 9.4
<S[redacted]> Ok. I can put that on the page...
<S[redacted]> Everyone can email me the links and ideas and stuff like that agreed opts.
<E[redacted]> Will you save transcripts of these meetings? 2.7
<S[redacted]> I think we are supposed to. I tried to log this, but I don't know if it worked 1.2 2.7
<S[redacted]> Ok, I just checked, and the log appears to have worked 6.5
<E[redacted]> We have some of it (almost everything). We'll mail it to you. Links to these would be great to have as well. 2.7
<E[redacted]> Ok...
<S[redacted]> Ok, I'll work on that 9.3 / 3.4
<S[redacted]> To sum up what we will be doing:
<E[redacted]> So, about the spec. What should we do? Both halves write a complete draft, then compare, discuss and merge? 1.9 -1
1.4
<S[redacted]> Both teams will work on the specs (rough drafts)
<S[redacted]> You guys start thinking about the navigator (get some ideas) since you have some experience with that 4.4
<S[redacted]> We will look into the client/server and the actual web interface. We will also bug Carl about the code.
<S[redacted]> I will email carl and get more info about the specs and get working on a bulletin board
<S[redacted]> Does that work for everyone?
<E[redacted]> We think so. Give us a couple of minutes to discuss and think of things we have forgotten to mention, ok?
<S[redacted]> ok
<E[redacted]> Ok. We can't think of anything special. 9.1
<S[redacted]> Ok, if you do, just email it, or put it on a page and send me the URL.
<E[redacted]> For your information. Erik will be gone saturday to thursday (skiing!!!) next week. 8.6
<S[redacted]> Ok
6.1

Page Differences - 5

Deduct

4 -0

2.1 ✓

<S[redacted]> Can He[redacted]k and K[redacted] still meet on Tuesday at 2:30(8:30)?
<E[redacted]> Ok.
<E[redacted]> Same time, same bat-channel! 7.4 agreed 0-pts!
<E[redacted]> =D 8.5 ✓ 6.7 ✓
<S[redacted]> Alright. Then, have fun skiing, E[redacted], and we'll see K[redacted] and H[redacted] next Tuesday
<S[redacted]> :P 8.1 2.6 ✓
<E[redacted]> Okii.. well well.. Is this over now? Are you leaving us here??!?!?! 8.6 ✓
<E[redacted]> =D 8.1 ✓ 2.10 ✓
<S[redacted]> Well, actually, D[redacted] and J[redacted] had to leave right at four, so I am alone here :(8.7 ✓ 4.1/2.6 ✓
<S[redacted]> Shall I do my leadership thing and officially adjourn this meeting? :) 8.1 ✓
<E[redacted]> Ok. If thers's anything we'd like to say, we'll mail everybody about it. More communication is better than less! SB 9.1 agreed - 0-pts.
<S[redacted]> I agree 9.6 ✓
* S[redacted] gets out the gavel
<E[redacted]> Please, do your thing, S[redacted]! 4.4 ✓ 2.1 ✓ 2.2 ✓
<S[redacted]> meeting adjourned. We'll meet again next week, same time, same place
* Sh[redacted] hits the desk with the gavel
<E[redacted]> Party time!
<S[redacted]> Bye! 6.3 ✓
<E[redacted]> Bye. 6.3 ✓
*** Disconnected

Page differences - 2

MC phrases - 123
No differences - 21
102

MC phrases - 123
Tot deducted - 7
matched phrases - 116

IS - Feb 16 1999

Deduct -3

T[redacted] meeting5_log.htm

Session Start: Tue Feb 16 15:17:42 1999
*** Now talking in #brio
<S[redacted]> Ok. 1.4
<D[redacted]> I am working on the Position Daemon, it is not very complicated. 6.8
<K[redacted]> Im talking with some REAL guru's on RMI - 4.9
<K[redacted]> =) 8.1
<J[redacted]> I'm getting the client running 1.4
<E[redacted]> Ok. Cool. Are you experiencing any troubles with Java? 11.7 - agreed - opts
<J[redacted]> not as yet
<S[redacted]> So, when am I going to get everyone's pictures? 1.7 - agreed - opts
<D[redacted]> S[redacted]: Did I already give you that stuff? 11.8 - agreed - opts
<S[redacted]> Yes and no.
<S[redacted]> I need to know what is public/private and the variable names. 11.7 4.5 agreed - opt.
<S[redacted]> I already have the rest drawn up, for the most part. - 11.1
<D[redacted]> We will talk tomorrow, OK? 2.1
<S[redacted]> ok
<J[redacted]> I will get it to you by Thurs evening - 1.7
<S[redacted]> J[redacted]: by 3:00? 11.7 - agreed - opts
<J[redacted]> ok 2.1
<D[redacted]> Should be meet again before this is due ?? Just so everyone can look things over and make any comments?
<S[redacted]> Everyone also needs to let me know what parts communicate with each other... 1.4 4.1 agreed - opts SB 3.5 agreed - opts
<S[redacted]> Well, that was the point of today's meeting...but I don't have all the stuff yet from _certain people
<D[redacted]> S[redacted]: new deadlines ?? what are they?? SB 6.2 agreed - opts.
<S[redacted]> Ok new deadline: 8.6
<S[redacted]> I want EVERYONE'S pics and comments and all of that stuff to me NO LATER THAN 3:00 thursday 1.7 1.6 As previous agreed - opts
<K[redacted]> S[redacted]: GOT that! 8.6
<S[redacted]> At 3:01, if I don't have everything, someone will be in BIG trouble 7.3
<K[redacted]> =) 8.2
<J[redacted]> aye aye chief 7.2 8.6 agreed - opts agreed - opts.
<S[redacted]> Any questions? 11.7 11.12
<D[redacted]> what about the test programs?? 9.1 1.3
<E[redacted]> How about collaboration diagrams?
<S[redacted]> Everything! SB 4.1 agreed - opts. SB 11.12 agreed - opts.
<S[redacted]> Test programs should be done by then, too...I would think... 1.7
<E[redacted]> If you want, I can read up a bit on those and try to give a similar description... Do you want me to do that? 1.9 1.4 agreed opts.
<S[redacted]> Yes, that would be great.
<S[redacted]> I looked at the page that Carl has a link to, and there is a really good description of coll. diagrams there. 9.4
<K[redacted]> Ill focus on the specs first. 1.6 11.12
<E[redacted]> Hey... Test programs as well. That's too much for me. I have a giant deadline in another class this friday. Can't we say Sunday for the test programs? 1.7 - 4.6
<E[redacted]> Ok. Got that about collaborations and Carl.
<S[redacted]> Only on ONE condition: They are in HTML format and ready to be put right on the web. Remember that the specs are due Monday. 9.4 1.7 SB 4.2 agreed - opts.
<S[redacted]> For the test progs: do we just need to have a description of what, why, how, and then the code? 1.2
<E[redacted]> Ok. You want the code for the test programs html:ed. Fair enough... I'll do that. 1.4 SB agreed opts. SB 11.12 agreed - opts.
<J[redacted]> that's what Carl's page says SB 4.9 SB 11.12
<E[redacted]> I suppose so. SB 8.9 agreed opts
<S[redacted]> Ok, and if ANYONE doesn't have their test progs to me, in HTML format, by Sunday at 4:00 US time, they will feel my wrath - even if I have to fly to Sweden! Understood? 4.1 1.7
<E[redacted]> I'll flee to Norway this Sunday... :) 8.5 7.2 7.1
<S[redacted]> I'll hunt you down! :) 8.5 7.2

Page Difference - 23

Deduct (-2)

<Sh[redacted]> By Thurs, when all the class/coll diagram stuff is due, I also need emails about what parts communicate, so you guys better be talking to each other, ok? 1.7 ✓ 4.1 ✓ 1.9 ✓
<E[redacted]> Sure thing!
<Sh[redacted]> Everyone else? Do you have all this? 5.1 ✓
<E[redacted] D[redacted]: I'd like to communicate with you, ok? :) 8.2 ✓
<Ja[redacted] yes ma'am 7.3 ✓ 7.3 — agreed-opts.
<S[redacted] H[redacted]k? K[redacted]? D[redacted]? 5.1 ✓
<E[redacted] D[redacted]: It's about positioning and stuff...
<D[redacted]> E[redacted] ok
<Ka[redacted] Always!
<Ja[redacted] I have to leave in a few minutes....when the next meeting?? 2.1 ✓
<Sh[redacted]> Good question...
<Sh[redacted]> We can't meet until I have all this stuff done... 1.7 ✓ SB 2.1 — agreed-opts.
<D[redacted]> ok
<K[redacted]> =) 8.1 ✓
<D[redacted]> Do you guys want me to call you on the phone? 2.8 ✓
<Sh[redacted]> We have to meet either Saturday or Sunday 2.1 ✓
<J[redacted]> I vote for Sunday 2.1 ✓
<D[redacted]> Sunday 2.1 ✓
<K[redacted]> E[redacted] would.. but I can go with Irc 2.8 — agreed opts.
<K[redacted]> -->d[redacted] — 8.5 ✓
<E[redacted]> Sure Dy! :) Call us and have a cheap transatlantic chat! :) 8.5 ✓
<D[redacted]> I just thought it would be different 7.1 — agreed-opts.
<D[redacted]> I can call for free 2.1
<Sh[redacted]> D[redacted]: Let's call them Friday! :) — 9.1 ✓
<K[redacted] COOOL! 8.6 ✓
<E[redacted] In that case... Suree 8.6 — agreed-opts
<Ka[redacted]> wowoow
<D[redacted]> what is you phone number?? SB 6.2 — agreed-opts.
<Sh[redacted]> D[redacted]: are you going to call from work? 6.2 ✓
<D[redacted]> no
<J[redacted] So when is the next meeting> 2.1 ✓
<Sh[redacted]> Can I be there too, then? :) 8.1 ✓
<E[redacted] Mine is: +46(0)18 511581 6.4 SB 6.2 — agreed-opts.
<D[redacted]> from Norm's work
<Sh[redacted]> Can I be there anyway? :) 8.1 ✓
<E[redacted] Next meeting, Shell? 2.1 ✓
<D[redacted]> I have never called another country if it doesn't work we 4.5 — agreed-opts
<S[redacted] Saturday or Sunday? 2.1 ✓
<D[redacted]> need to have a back up plan 9.1 ✓
<J[redacted] when is the next meeting....when is the next meeting....when is the next meeting 8.6
SB 2.1 SB 5.1 — agreed-opts
<Sh[redacted] email them..and let them know 4.1 SB 5.2
* Sh[redacted] says "hold on J[redacted]! We're working on it!"
* Sh[redacted] says "Saturday or Sunday, people?" 2.1
<H[redacted] Sunday 2.1 ✓
<D[redacted]> Sunday 2.1 ✓
<Ja[redacted] Sunday 2.1 ✓
<S[redacted]> Ok...how about 1:30? 2.1 ✓
<J[redacted]> ok 2.3 ✓ SB 9.4 — agreed-opts.
<H[redacted]> Ok 2.3 ✓
<E[redacted] D[redacted]: To call Sweden from where you are, I think that you dial: 0114618511581
<Sh[redacted] which one?
<D[redacted]> Is it ok if i can't make it Sunday? 2.10 ✓
<Sh[redacted]> You voted for Sunday!! SB 5.1 — agreed-opts.
<Sh[redacted] What about Saturday morning? 2.1 ✓
<Sh[redacted] Early...like 8:00...
<D[redacted]> I am supposed to be at my parents 6.1 ✓
<D[redacted]> I know but i was thinking later, I forgot about the time thing 6.7 agreed-opts
<Ka[redacted] I say AYE so sunDAY SB 2.3 — agreed-opts.
<Ka[redacted] to

Page Diff - 19

Deduct -4.5

SB 2.7 - agreed 0pts.

<E[redacted]> Sunday is best for me. 6.1
<S[redacted]> Ok, then, D[redacted] will have to miss the meeting..
<D[redacted]> I can just read the meeting log, but you guys can't talk about me 7.1
<S[redacted] D[redacted]: I edit the log. :) 7.2/8.5
<J[redacted]> would we do that?? 7.2
<D[redacted]> I know, I still do not want you to talk about me ! 7.1
<S[redacted]> I won't...It's those Sweden boys to worry about!! :) 7.2/8.5
<s[redacted]> i wont
<D[redacted]> E[redacted]k and [redacted]e are you by the phone now?? 6.2
<E[redacted]> No.
<H[redacted]e> You can call me on my mobile phone
<D[redacted]> what time should i call you, ~~it has~~ to be before 5:30/US time 2.1 SB. 2.8
<J[redacted]> ok...i have to go now..... 6.3 -1
<Sh[redacted]> bye J[redacted] 6.3
<D[redacted]> See Ya 6.3
<S[redacted]> That shouldn't be a prob: that's 11:30 Sweden time. 2.1 -1 agreed-0pts
<H[redacted]> bye J[redacted] 6.3
<S[redacted]> What day are we calling? 6.2
<E[redacted]> By Ja[redacted] 6.3 -1
*** J[redacted] has left #brio
<D[redacted]> I was going to call today 2.8/2.1
<S[redacted]> Today/?
<D[redacted]> we can call friday too 2.8/2.1
<S[redacted]> What time friday?
<S[redacted]> What time today? 2.8/2.1
<D[redacted]> before 5:30
<S[redacted]> Hmm....
<S[redacted]> Can you do a conference call, and call me too? 6.6 2.4 agreed 0pts
<D[redacted]> Smith Barney closes at 5:30
<D[redacted]> I can try
<S[redacted]> Ok. :) 8.1
<S[redacted]> You have to wait until we get off of here, though...
<S[redacted]> yep.
<E[redacted]> And you'll have to wait for us to get home.
<D[redacted]> E[redacted] and K[redacted]e what time? 2.1
<S[redacted]> All of you go to one person's house... 9.1/4.1
<S[redacted]> Dy: what time do you work on Fri? 6.2
<D[redacted]> I will come home after the test in 462 6.4 agreed-0pts.
<S[redacted]> Hmm...I have class until 4... 6.4
<S[redacted]> How about we try the conference call thing? 9.1
<D[redacted]> just get here before 5:30 2.4
<K[redacted]> Hello.. now we've decided on time and place.. my place 10.40
<S[redacted]> I was supposed to bring Kathy, remember? 2.4
<D[redacted]> that's ok
<S[redacted]> But, I think she has a meeting until 5...
<S[redacted]> I can double check
<S[redacted]> K[redacted]: today?
<D[redacted]> so 4:40/US time is that right 2.1
<D[redacted]> at 0114618511581 9.4 7.1
<E[redacted]> To get to Kalle: 0114618512632
<S[redacted]> Or, you can just keep them on the phone until I get there on Friday!! :) 8.5
<S[redacted]> :) 8.5
<E[redacted]> Not the number you mentioned. That will get you to my sleeping girlfriend. That could be fun, but maybe not... :) 6.1/7.2 .5 8.5
<D[redacted]> you are 6 hours ahead, right? 6.6 - agreed 0pts.
<K[redacted]> correct
<K[redacted]> We have to go now if we should make it 2.6
<D[redacted]> ok i will call you at 10:40 and M[redacted] I will try to connect you too 2.4 -1
<D[redacted]> S[redacted]: stay off the phone
<S[redacted]> Ok. call me at least to let me know if it didn't work, ok? SB 9.1 - agreed-0pts.
<Sh[redacted]> I will. :) 8.1

Page Diff - 12

<H[redacted]> Ok bye then 6.3
<E[redacted] Talk to you later then! 6.3
<D[redacted]> Bye 6.3
<Sh[redacted] bye 6.3
*** D[redacted] has left #brio
*** H[redacted] has left #brio
*** Disconnected
Session Close: Tue Feb 16 15:55:00 1999

Page differences - 0

MC - Phrases 149
No. diff - 54
Tot 95

MC Phrases - 149
Tot deduct - 9.5
Tot Match - 139.5

Master Copy
IC-1 (Test 2)
IC-2 (Test 1)

For Validation:
T6 - E7 - p. 4
T4 - E14 - p. 13
T13 - I1 - pp. 1-5
T13 - I10 - pp. 1-2

E7 Results
- Master copy -
Total Coded Phrases - 8

- Independent coder 1
matched phrases - 8
differences - ∅

- Independent coder 2
matched phrases - 7
differences - 2

Allendale MI 49401 | 616.895.2100 fax

E7
RR06
1/2/00

```
Received: (qmail 26611 invoked by alias); 1 Feb 2000 12:29:49 -0000
Delivered-To: b[redacted]edu
Received: (qmail 26608 invoked by uid 0); 1 Feb 2000 12:29:48 -0000
Received: from river.it.gvsu.edu (148.61.1.16)
  by csis.gvsu.edu with SMTP; 1 Feb 2000 12:29:48 -0000
Received: from localhost (reifferr@localhost)
      by river.it.gvsu.edu (8.8.6 (PHNE_17190)/8.8.6) with SMTP id HAA23303
      for <[redacted]; Tue, 1 Feb 2000 07:29:48 -0500 (EST)
Date: Tue, 1 Feb 2000 07:29:48 -0500 (EST)
From: [redacted] <[redacted]u>
To: [redacted]du
Subject: Times for meetings.
Message-ID: <Pine.HPP.3.95.1000201072543.21263D-100000@river.it.gvsu.edu>
MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
```

Hello - 6.3

The times over here are 6 hours behind Sweden time. Therefore, lets set a time to use. We can use Sweden time when we discuss what time to meet since there are four of us over there and only two over here. - 2.1 (6.6)
Also, the only morning that works good for me is Tuesdays unless we meet at 11:00 Sweden time or 5:00AM EST which I don't have a problem with but John might.
One last thing. What programming experience does everybody have? - 6.2
Personally, I have not done any programming in Java but I have done a lot in c++. Please let me know. 4.5 4.3

Thanks, - 6.9
[redacted]
9.3

Received: (qmail 26921 invoked by alias); 1 Feb 2000 12:30:51 -0000

E14 - Results

- master copy -

Total Coded Phrases - 7

- Independent Coder ① -

- matched phrases - 7

differences - 0

Independent coder ② -

- matched phases - 7

differences - 2

1.2

E14

Linda J.

4/2/02

Received: (qmail 23462 invoked by uid 0); 4 Feb 2000 14:18:39 -0000
Received: from [redacted]u ([redacted]0)
  by turing.csis.gvsu.edu with QMQP; 4 Feb 2000 14:18:39 -0000
From: [redacted]du
Date: Fri, 4 Feb 2000 09:18:38 -0500 (EST)
To: [redacted]du
Subject: Re: Meeting time
In-Reply-To: <OFB8099A1A.F3F2D8F0-ON8525687B.004C7BDE@mailrouter.net>
Message-ID: <Pine.LNX.4.10.10002040912530.30358-100000@eos10.csis.gvsu.edu>
MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII

Hi everyone! - 6.3 3.5 / 2.1

How would Wednesday, February 9, at 9:00 AM Michigan time work for everyone? The only days I cannot meet in the morning next week are Tuesday and Thursday. We got to get together and have a pow-wow! - 6.1

7.1

8.6

Have a GOOD Weekend! - 6.3

[redacted]

Received: (qmail 5104 invoked by uid 0); 7 Feb 2000 13:36:00 -0000
Received: from merganser.its.uu.se (130.238.6.236)
  by csis.gvsu.edu with SMTP; 7 Feb 2000 13:36:00 -0000
Received: from bifrost1445-1.n.it.uu.se ([130.238.9.129]:61861 "HELO
      freddanslap") by merganser.its.uu.se with SMTP id <S249916AbQBGNfN>;
    Mon, 7 Feb 2000 14:35:13 +0100
Message-ID: <000b01bf716f$98f27bc0$350a0a0a@freddanslap>

Log 0131 I1- 01/11/00

IRC log started Mon Jan 31 21:29

*** Value of LOG set to ON -1.2/1.3

<L[redacted]> Given the "picture" of the surface, we are supposed to mimic the user's path by elevating the surface accordingly.

<L[redacted]> Um . . Not sure what else to say about it.

<L[redacted]> Is this still making sence? - 6.2

<m[redacted]s> Certainly.

*** Value of LOGFILE set to brio[redacted]

<L[redacted]> Does it make you cringe like it has for many people on this end? - 7.1

<L[redacted]> hehehe

<ma[redacted]> Our teacher, Arnold Pears, is probably still with you in Grand Valley - that's why we don't know much yet. - 4.10

<L[redacted]> still "with" us?

<L[redacted]> as in physically? > 6.2

<m[redacted]> It doesn't seem to horrible. It'll take some time, I guess, but not impossible. 6.8

<L[redacted]> No. definitely not impossible. Time is the main issue. 6.8

<L[redacted]> Your on a 10 week schedule (this is what I've been told) . . . if you started when we did that gives us 7 or 6 weeks to crank this out. - 4.10/6.6

<m[redacted]> Well, in order to make use of time maximally we should try to divide all work carefully, so that we could work in parallell. 1.9

<L[redacted]> I would have thought that your instructor would have given you at least some inclination as to what this project is going to entail. - 4.10

<m[redacted]s> *checking calendar*

<L[redacted]> When possible. There will obviously be times when that won't be possilble.

<A[redacted]> We will have our first lecture next wednesday, I think. - 4.10

<ma[redacted]> That's when we'll get some more info... - 4.10/6.1

<d[redacted]> We will know about the project in tomorrow - 4.10

<L[redacted]> Erickson's site indicates that you'll find out about this next week. - 4.9

<m[redacted]> And from then, there's only five weeks *phew* - 1.7

<L[redacted]> .. Erickson had originally told us Tuesday but .. now it is Thursday.

<L[redacted]> It keeps getting pushed back . . . and back . . . 4.10/4.9

<L[redacted]> Has your instructor said anything about the "introduction" of the fellow teammates? 6.2

<m[redacted]> And the schedule gets tighter and tighter... - 4.10

<L[redacted]> And they wonder why we stay up all night . . . - 4.10

<A[redacted]> Only that we are supposed to a presentation in the form of a 'creative' webpage - 1.2

:) 8.1

<m[redacted]> Well, our instructor is in Grand Valley... :-) But we got a piece of paper with some instructions. 6.4 8.1 4.10

<L[redacted]> Creative huh?

<L[redacted]> :) 8.1 9.6

M? > can you distribute all info that you will be given on thursday? - 9.1

<L[redacted]> How versed (yes I will do that . .) are you guys with HTML? 9.3

<L[redacted]> If you want I can post it off my site. 9.1

<L[redacted]> Or e-mail it .. how ever you preffer.

<ma[redacted]> I could do something in case of emergency. But if you like, you're welcome to take care of it. - 1.4

<L[redacted]> Your to kind . :) 7.1 8.5

<m[redacted]> Sure. :-) 8.5

<L[redacted]> Is the "presentation" due prior to the end of the project? 1.2/1.7

2.2 (end) <L[redacted]> I guess . . . do you know where my site is? 9.3

<m[redacted]> I think we could do what is called 'team building exercise' very soon. L[redacted]e right now, perhaps? - 1.7 1.3

<L[redacted]> Or if you want, we could wait till S[redacted] is present. - 9.1/2.10

> thats better

<m[redacted]> That's a good idea. M[redacted] got a bit depressed here. :-) - 8.1

<m[redacted]> Just kidding. 7.1

> 9.6

<L[redacted]> :) 8.5

<L[redacted]> The computers that any of you use . . . are they on campus or do you have home computers? -6.2
> for chatting or?
<m[redacted]s> Right now we're all in school. But we all have computers at home, too. -6.4
<L[redacted]> What type or kind of connection? -6.2
<m[redacted]> We found it easier to start up when all are present here. -9.1
<L[redacted]> I've just got a measly little 28.8 connection due to my living out in the sticks.
<L[redacted]> 28.8 modem that is. -6.4
> do you have homepages with some presentation of yourselves? -6.2
<m[redacted]> I got a T1, but most of us (like the other two) use modems. 6.4
<d[redacted]> Yes, we have homepages -6.4
> please give us the URL:s -6.2
<L[redacted]> :) hehehehe I have friends that use Cable Modems. I do have a site .. however, it doesn't go into to much detail about myself (I know .. been there. :)) -8.1 6.4
<L[redacted]> http://www.csis.gvsu.edu/~[redacted] -9.4
<L[redacted]> the other's here will follow with ~username
> www.m[redacted]g.net -9.4
<m[redacted]> Hey, you got a strange color.... =) -8.5
<L[redacted]> To much sun :) 7.2 8.5 7.1
<m[redacted]> I guess so. -7.2
<L[redacted]> You want so see something rediculous . . . -7.2
<m[redacted]> :-) -8.5
<m[redacted]> Sure...
<L[redacted]> go to my site . . > Favorites > Files-CSIS
<L[redacted]> Look at the .JPG file. 7.2
<L[redacted]> That is an image of my first Drivers License
<A[redacted]> :D -8.5
<m[redacted]> Ok - now I got a better idea. I do hope the colors are negative on your homepage by purpose. -7.2
*** i[redacted]s (piotten@irchat-51421.telia.com) has joined channel &brio[redacted]
<L[redacted]> Yes. The state screwed up . . . I though t it was worth the $6.00 to get a new one. -7.2
> jahaja
<i[redacted]s> stabilt -7.2
<m[redacted]s> Otherwise, if they're negative only in my browser, I might have offended you seriously... -7.2
<L[redacted]> :) -8.5
> piss off -7.2
<i[redacted]> i'd like some spam, spam, spam, spam with spam. -7.2
<m[redacted]> Morgans last comment was not directed at you americans, but at the moron i[redacted]... -6.1
<m[redacted]> ...who happens to be one of our classmates.
<L[redacted]> mattis may "give em de boot" -7.1
<i[redacted]s> don't listen to that crap
<L[redacted]> he is the channel "Operator" -6.1
<i[redacted]s> i'm the supervisor of this whole project
<m[redacted]> How do I do that? -6.2
<L[redacted]> hang on . .
<i[redacted]> err bll
*** i[redacted]s has left channel &brio[redacted]
<m[redacted]> Uffe var tyst! -7.4
P3(end) <m[redacted]> Okay - he left. 6.2
Morgan > allright when the bug has left, do you want to see a pic of me?
<d[redacted]> yes -6.4
> http://boes.org/gallery/photo25.html up in the left corner -9.4
<L[redacted]> what is your client that your using? -6.2
<m[redacted]> Well, our client is just called 'irc' and is probably a basic Unix feature. 9.4
<L[redacted]> it still should have some options to boot people 9.1

<L[redacted]> did he leave or did he just go invisible? 6.2
<m[redacted]> If you've viewed those pictures now, then you should now he is a few years older by now. He is a real prodigy. 7.1
<m[redacted]> He left,
<m[redacted]> it[redacted] that is.
<L[redacted] 8) —8.1
> by the way it's not obvious by the name that I'm male —6.1
<L[redacted] So is J[redacted] 6.4
<L[redacted]> (L[redacted] that is)
i[redacted]s tjena stefen
<L[redacted]> you can type /whois [username] minus the brackettes -9.4
it[redacted]s du skriver meddelanden till mig med /msg i[redacted] <jättesnälla kommentarer här>
<ma[redacted]> My homepage can be found at www.docs.uu.se/~it97maf —9.4
-> *i[redacted]s* glekrjkrjrkrjkrlewrerkjewr
<L[redacted] I am assuming A[redacted] is a female . . ??? 8.6 6.2
i[redacted]s just
<L[redacted]> I went to school with an A[redacted] —6.1
<m[redacted]> There's a link there that says 'pictures'. I intended it to be a photo album, but I never completed it. —6.4
> a boy annica? — 6.2
<A[redacted]> Quite right.... :) —6.4 8.1
<L[redacted]> Just making sure.
<A[redacted]> I/
<m[redacted]> You never know, these days. 6.2
<L[redacted]> Would it be to rude to ask what the age of everyone is . . . unless it is an irrelevent topic . . skip it. Just curious.
<ma[redacted]s> I don't look like that nowadays, I guess. —6.4
<L[redacted]> J[redacted] => 25 —6.4
> 28 —6.4
<m[redacted]> 24 on the 25th. —6.4
<A[redacted]> The same goes for me —6.4
<m[redacted]> A[redacted] is having trouble deciding. —7.1
<L[redacted]> the it97### . . . is that when you enrolled at your university. —6.2
<m[redacted]> Yep.
<L[redacted]> Indecisive huh? —7.1
<d[redacted]> same mattis
<L[redacted]> I started at Grand Valley the fall of 96 . . —6.1
<A[redacted]a> They are very, very bad boys... :(— 9.5 x2
<L[redacted]> Anyone Married? 6.2
> :) —6.
<L[redacted]> Kids?
<L[redacted]> Family — 6.2
<L[redacted]> ?
<L[redacted]> Grand Children? —x.1
<A[redacted]> No
<A[redacted]a> No — 6.4
<A[redacted]> No
<L[redacted]> Great Grand Children — 6.4 x.2
<L[redacted]> hehehehehehe
> a girlfriend and a cat — 6.4
<L[redacted]> was that a yes morgan? — 6.2
<m[redacted]> He is the grandfather around here. —7.2
> not married :) —6.4 8.1
<L[redacted]> Jason is.
4 (End) <L[redacted]> Happily too.
<L[redacted]> 2 kids. 6.4
<L[redacted]> 3 and 5
<m[redacted]s> Impressive.
<L[redacted]> As I stated earlier . . . time may be an issue. . . but doable. —6.8
<L[redacted]> Just need to communicate.

<ma[redacted]> Sure. Nights are great for programming.
<L[redacted]> What are you guys using for Java? – 6.2
<ma[redacted]> What we could do now is to try to find a time for meetings that suits everybody. – 9.1
<ma[redacted]> What do you mean, 'for Java' ? A linux machine? – 6.2
<L[redacted]> well . . . S[redacted] indicated tomorrow – 2.1
<L[redacted]> Um . . are you using JBuilder? – 6.2
<L[redacted]> or just some command line tools. 6.4
<m[redacted]> Nope. javac. More macho that way. – 7.1
<m[redacted]> command line, that is. 6.1/4.3
<L[redacted]> What JDK . . . I've been diong all my C and C++ programming that way. Fell in love with an ascii text editor . . . found myself being more productive with that then the fellow student(s) that used TurboC and it's projects.
<A[redacted]> Visual J++ – 6.4
<L[redacted]> However, recently, I have run into a little "issue" of not being able to read in long file names in my editor so I snagged JBuilder. 6.1
<ma[redacted]> Linux and emacs. Works great. JDK. 6.4
<L[redacted]> JDK . . I'm using 1.2.2 of Suns. 6.4
<m[redacted]> So am I. – 6.4
> me too – 6.4
<L[redacted]> A[redacted]? 6.2
<Ar[redacted]> Going to install that too 6.4
<m[redacted]> d[redacted]? – 6.2
<L[redacted]> GVSU has an IBM and the SUN available. – 6.4
<L[redacted]> If it is unanimous that we use Sun 1.2.2 then there "shouldn't" be an issue. I'd prefer Sun.
<m[redacted]> Sure.
<dr[redacted]> I am using SUN in school – 6.4
<L[redacted]> Of course i would . . . i have everything setup for it . . . – 6.1
> I like the SUN in the sky – 7.1
> hate unix – 6.1
<m[redacted]> I think morgan has lost it. – 7.2
<L[redacted]> Which . . you've not seen much of lately. – 7.2
<L[redacted]> correct?
<L[redacted]> What does m[redacted] like instead of unix? – 6.2
<ma[redacted]> He's running around like a maniac laughing. 7.2
<ma[redacted]> Did you say S[redacted] wanted a meeting tomorrow? – 2.1
<L[redacted]> I take it that all of you are in a computer lab? 6.2
<L[redacted]> yes.
u[redacted]n stef
<m[redacted]> Yep.
<L[redacted]> grr. hang on . . . clicked the wrong button... 6.1
> it's ok whith unix too, just kidding but I prefer to work in windows
<ma[redacted]> Then we could perhaps go for the same bat time, same bat channel? :-) 8.5
<L[redacted]> hmmmm He is suggesting 3:30 + 1 GMT Tuesday. – 2.1
<ma[redacted]> I mean the same time, same channel tomorrow? 2.1 2.2/2.1/7.1
> ok for me 2.3 3
<A[redacted]> Fine – 2. 7.2 8.5
<ma[redacted]> Seems I'm the only fan of 60's batman TV-series... Strange. ;-)
<L[redacted]> Same time won't work . . we all (here) will be in the Brio class. 2.1 6.1
<L[redacted]> We will be done at 4:15
<ma[redacted]> Earlier? – 6.2
5(end) > zzzzzzzzzzzzzz – 7.1
<L[redacted]> IF the AM (our time) is preffered . . hmmm then I will need talk to my manager at work . . 6.1
<L[redacted]> it is doable.
<L[redacted]> 3:30 GMT+1 – 2.1
<ma[redacted]> Didn't you say you're class was moved until thursday? 6.2
<L[redacted]> no . . . not the class ... the topic. 6.4
<m[redacted]> ok.
> let's take tomorrow, it's ok 2.1

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<m[redacted]> Tomorrow, then - 22:15 our time = 4.15 pm your time. -2.1
<ma[redacted]> Ok with everyone? 3.5
<L[redacted] um . . If you want .. otherwise I can be here in the am. -2.1
<A[redacted] Yep -2.3
<d[redacted]> Ok -2.3
<L[redacted]> :) - 8.1
> i haven't went to sleep before 02.00 am this year - i like eavenings -6.1
<m[redacted]> Actually, it would be fine by me - but then I'd be chatting fromhome. -6.1
We all would. 6.4 2.3 -2.2
<L[redacted]> . . Home would be okay . . I might have to fine a Winblows IRC chat client . . . not a problem. My connection just isn't very fast. -6.6
<m[redacted]s> But you're using it right now, and it seems to work fine enough - to us, at least. 6.4
<L[redacted]> So we are agreed on 22:15 GMT + 1? -2.1
<L[redacted]> no . . I am on campus right now.. -6.1
<L[redacted]> :) -8.1 8.6
<L[redacted]> BIG difference. -6.6
<L[redacted]> I've telneted into my account and run BitchX and it is SLOOOOWOWWW -8.6
<m[redacted]> No, not 22:15 GMT - no good. 4:15 your time. -2.1
<L[redacted]> Either way . .
<L[redacted]> I'll figure out some way to get in and chat. -6.6
<m[redacted]> 21:15 gmt = 4:15EST. -6.4
<L[redacted]> um . . . didn't I state 22:15 GMT+1 8) -8.1
<L[redacted]> oh .. it say GMT + 1
<L[redacted]> Tomorrow after class. -2.1
<m[redacted]s> Ok, now I get it... I misunderstood.
<L[redacted]> (for us.
<m[redacted] Yup - see you tomorrow then. (Or write you, I suppose.) 6.7
<L[redacted]> I'll be there. Now all we need to do is confirm with S[redacted] -2.3
<m[redacted]> You'll take care of that? -6.2
<L[redacted] Yes . . I'll e-mail him tonight. .. or this afternoon. 6.4
<L[redacted] For now it is in the afternoon.
> allright, see you tomorrow then -6.7/6.3
<L[redacted]> evening. 6.3
<L[redacted]> Night.
<m[redacted]> Night here. -6.4
<L[redacted] depends on what you want to look at it from :) -8.1
<d[redacted]> Night
> the SUN is black -7.1
<m[redacted]> Couldn't agree more. Goodnight! -6.3
<L[redacted]> Here . . the sun is gray. -7.2
<L[redacted]> (clouds) .
<L[redacted]> Night. -6.3
> cu -6.3
<L[redacted] Talk to you guys(gales) tomorrow. -6.7/6.3
*** Signoff: m[redacted] (Quit: Leaving)
<A[redacted]> Bye then. 6.3
<L[redacted]> Night. -6.3
*** L[redacted] has left channel &brio[redacted]
IRC log ended Mon Jan 31 22:21

Link = Jason
Mattis = Mattis
Annica = Annica
Dragon = ? - Phuong
> = ? Morgan -

I1 - Results
Master copy -
Total Coded Phrases - P1 - 44
P2 - 36
P3 - 36
P4 - 43
P5 - 39
Total - 198

- Independent Coder 1 -
- matched phrases - 177.5
No differences - 42

- Independent Coder 2 -
- matched phrases - 188
No differences - 140

Log 0224

I10-24/2/00

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```
IRC log started Thu Feb 24 14:34:31 2000
ùíù BitchX: Auto Response is set to - marsmans
ùíù Connecting to port 6667 of server csis.gvsu.edu [refnum 0]
-Brio.csis.gvsu.edu(***)- Looking up your hostname...
-Brio.csis.gvsu.edu(***)- Checking ident...
-Brio.csis.gvsu.edu(***)- Found your hostname
-Brio.csis.gvsu.edu(***)- Received ident response
ùíù BitchX: For more information about BitchX type /about
ùíù Welcome to the Brio IRC Network Scott.(~[redacted].csis.gvsu.edu) (from
Brio.csis.gvsu.edu)
ùíù Your host is Brio.csis.gvsu.edu[turing.csis.gvsu.edu], running version
Elite3.1 (from Brio.csis.gvsu.edu)
ùíù This server was created Thu Feb 17 2000 at 11 02:35 EST(from
Brio.csis.gvsu.edu)
ùíù Brio.csis.gvsu.edu Elite3.1 oiwsghkcfrabexAOSNTCY biklmnopstvaxqRLKOA
ùíù [local users on irc(14)] 100%
ùíù [global users on irc(0)] 0%
ùíù [invisible users on irc(14)] 100%
ùíù [ircops on irc(0)] 0%
ùíù [total users on irc(14)]
ùíù [unknown connections(1)]
ùíù [total servers on irc(1)] (avg. 14 users per server)
ùíù [total channels created(3)] (avg. 4 users per channel)
ùíù Current Local Users  [14]  Max: [37]
ùíù Current Global Users  [14]  Max: [37]
ùíù MOTD File is missing
ùíù Mode change [+i] for user [redacted]
ùíù Mode change [+w] for user [redacted]
ùíù [redacted] [~[redacted].csis.gvsu.edu] has joined #brio[redacted]
ùíù Topic (#[redacted]3): milestone
ùíù Topic (#[redacted]3): set by [redacted] at Thu Feb 24 14:32:11 2000
ùíù [Users(#[redacted]:3)]
[ [redacted] ] [[redacted] ] [[redacted]s ]
ùíù Channel #brio13 was created at Thu Feb 24 14:30:06 2000
<S[redacted]> hi! - 6.3
ùíù BitchX: Join to #brio13 was synced in 3.845 secs!!
<m[redacted]> hi! - 6.3
<D[redacted]> hi - 6.3
#[redacted]   [redacted]    H   ~[redacted])
#[redacted]3  D[redacted]n  H   ~[redacted])
#[redacted]   m[redacted]s  H@  ~[redacted])
<S[redacted]> jason went over to the job fair - 8.10
<m[redacted]> You got a job fair right noe? - 6.2
<m[redacted]> now?
<m[redacted]s> that is.
ùíù m[redacted] [~[redacted]] has joined #brio[redacted]
<S[redacted]> yep - 6.4
<m[redacted]> hoho
<D[redacted]> it just like you go to shop for a job. - 7.1
<m[redacted]> Welcome - 6.3
<m[redacted]s> Yes, we got them too.
1(end) <m[redacted]> Will he be here in time for the meeting? - 6.2
<S[redacted]> yes - 6.4
<S[redacted] w/ carl, not now - 2.10
<m[redacted]s> Ok, thats what I meant too.
<S[redacted] has everyone looked at my milestone report? - 1.10
<m[redacted]> No - on the web? - 9.3
<S[redacted] yest
<S[redacted] yest
<S[redacted] yes
<S[redacted]> :) - 8.1
```

<m[redacted]> =) -8.1
ùíù SignOff m[redacted] #Brio[redacted] (Ping timeout)
ùíù m[redacted] [~i[redacted]] has joined #brio[redacted]
<m[redacted]> Now ping is messing with us again... -6.6
<S[redacted]> are you guys reading it? -9.3
<m[redacted]> yep
<D[redacted]> S[redacted]: Do we need to demonstrate to Carl in the other room.
<S[redacted]> yes
<m[redacted]> what are you actually reading? -9.3 4.9
<S[redacted]> I was over there, but Eric kicked me off -11.11
<S[redacted]> what do you mean, morgan? -9.3
<D[redacted]> He did. Why? -6.2
<S[redacted]> to run the video server
<S[redacted]> he was testing 11.11
<m[redacted]> you wrote: are you guys reading it? 6.8
<m[redacted]> I am reading - nice to see C-code that is easy to read and well commented. Guess I shouldn't be reading it now, though. =) -8.1
<S[redacted]> I meant the report and motor control program, m[redacted] -9.4
<D[redacted]> S[redacted] meant the milestone report3 on the web:m[redacted] 9.4
<m[redacted]> ok, just printing it out -6.1
<S[redacted]> I'm going to go over to the other lab. Be right back 9.4
IRC log ended Thu Feb 24 14:42:02 2000 6.1

I10 Results
- Master Copy -
Total Coded Phrases P.1 - 13
P2 - 14
Total - 27

- Independent Coder (1) -
- matched phrases - 25
- differences - 3

- Independent Coder (2) -
- matched phrases - 2[illegible]
- differences - 10

Final Results

matched	MC	matched phrases IC-1	IC-2
E7	8	8	7
E14	7	7	7
I1	198	177.5	188
I10	27	25	24
Totals 240		217.5	226
%		90.6%	94.2%
Differences		42 3 45	2 2 40 10 54
240-45= 195 $\boxed{81.3\%}$		240-54=186 $\boxed{77.5\%}$	

(Test-2.)

Sample Emails for validation

```
Received: (qmail 26611 invoked by alias); 1 Feb 2000 12:29:49 -0000
Delivered-To: [redacted]u
Received: (qmail 26608 invoked by uid 0); 1 Feb 2000 12:29:48 -0000
Received: from river.it.gvsu.edu (148.61.1.16)
  by csis.gvsu.edu with SMTP; 1 Feb 2000 12:29:48 -0000
Received: from localhost ([redacted])
      by river.it.gvsu.edu (8.8.6 (PHNE_17190)/8.8.6) with SMTP id
HAA23303
      for <[redacted]; Tue, 1 Feb 2000 07:29:48 -0500 (EST)
Date: Tue, 1 Feb 2000 07:29:48 -0500 (EST)
From: [redacted]>
To: [redacted]
Subject: Times for meetings.
Message-ID: <Pine.HPP.3.95.1000201072543.21263D-
100000@river.it.gvsu.edu>
MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
```

Hello 6.3 ✓

6.6 ✓

The times over here are 6 hours behind Sweden time. Therefore, lets set a time to use. We can use Sweden time when we discuss what time to meet since there are four of us over there and only two over here. – 2.1 ✓
Also, the only morning that works good for me is Tuesdays unless we meet at 11:00 Sweden time or 5:00AM EST which I don't have a problem with but John might.
One last thing. What programming experience does everybody have? 6.2 ✓
Personally, I have not done any programming in Java but I have done a lot in c++. Please let me know. – 9.3 ✓ – 4.3 ✓ 4.5 ✓
Thanks, 6.9 ✓
[redacted]

number of differences – 0   matched phrases – 8

```
Received: (qmail 23462 invoked by uid 0); 4 Feb 2000 14:18:39 -0000
Received: from eos10.csis.gvsu.edu ([redacted])
  by turing.csis.gvsu.edu with QMQP; 4 Feb 2000 14:18:39 -0000
From: [redacted]u
Date: Fri, 4 Feb 2000 09:18:38 -0500 (EST)
To: [redacted]u
Subject: Re: Meeting time
In-Reply-To: <OFB8099A1A.F3F2D8F0-ON8525687B.004C7BDE@mailrouter.net>
Message-ID: <Pine.LNX.4.10.10002040912530.30358-
100000[redacted]u>
MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
```

Hi everyone! 6.3 ✓

3.5 ✓

How would Wednesday, February 9, at 9:00 AM Michigan time work for everyone? The only days I cannot meet in the morning next week are Tuesday and Thursday. We got to get together and have a pow-wow! – 2.1 ✓ – 6.1 ✓ 7.1 ✓

Have a GOOD Weekend! 6.3 ✓
[redacted]

8.6 ✓

number of differences – 0   matched phrases – 7

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IRC number 1

Team members:

[redacted]) J[redacted]

[redacted]

[redacted] = (not present) N[redacted]

IRC log started Mon Jan 31 21:29
*** Value of LOG set to ON
<I[redacted] Given the "picture" of the surface, we are supposed to mimic the user's path by elevating the surface accordingly. - 1.2 1.3 agreed, no points
<I[redacted]> Um . . Not sure what else to say about it.
<L[redacted]> Is this still making sence? 6.2
<m[redacted]> Certainly.
*** Value of LOGFILE set to brio[redacted]
<I[redacted] Does it make you cringe like it has for many people on this end? - 7.1 agreed, no points
<I[redacted]> hehehe 7.2 one phrase as above
<m[redacted]> Our teacher, Arnold Pears, is probably still with you in Grand Valley - that's why we don't know much yet. 4.10
<L[redacted]> still "with" us?
<L[redacted]> as in physically? 6.2
<m[redacted]> It doesn't seem to horrible. It'll take some time, I guess, but not impossible. 6.8
<L[redacted]> No. definitely not impossible. Time is the main issue. 6.8
<L[redacted]> Your on a 10 week schedule (this is what I've been told) . . . if you started when we did that gives us 7 or 6 weeks to crank this out. 4.10 6.6
<m[redacted]> Well, in order to make use of time maximally we should try to divide all work carefully, so that we could work in parallell. 1.9
<L[redacted] I would have thought that your instructor would have given you at least some inclination as to what this project is going to entail. - 4.10
<m[redacted]> *checking calendar*
<L[redacted]> When possible. There will obviously be times when that won't be possilble.
<A[redacted] We will have our first lecture next wednesday, I think. 4.10
<m[redacted] That's when we'll get some more info... 6.1 4.10 - agreed, no points
<d[redacted] We will know about the project in tomorrow 4.1
<I[redacted] Erickson's site indicates that you'll find out about this next week. 4.9
<m[redacted]> And from then, there's only five weeks *phew* 1.7
<I[redacted]> .. Erickson had originally told us Tuesday but .. now it is Thursday. -1 4.9 4.10 agreed no points
<L[redacted]> It keeps getting pushed back . . . and back . . . 4.10 one phrase as above
<L[redacted]> Has your instructor said anything about the "introduction" of the fellow teammates? 6.2
<m[redacted]> And the schedule gets tighter and tighter... 4.10
<L[redacted] And they wonder why we stay up all night . . . 4.10
<A[redacted] Only that we are supposed to a presentation in the form of a 'creative' :) webpage 1.2 8.1 6.1 8.1
<m[redacted]> Well, our instructor is in Grand Valley... :-) But we got a piece of paper with some instructions. 4.10
<L[redacted]> Creative huh? 9.6 -1
<L[redacted]> :) - 8.1
> can you distribute ~~all info that you~~ will be given on thursday? - 9.1
<L[redacted]> How versed (yes I will do that . .) are you guys with HTML? - 9.3
<L[redacted]> If you want I can post it off my site. - 9.1
<L[redacted]> Or e-mail it .. how ever you preffer.
<m[redacted]> I could do something in case of emergency. But if you like, you're welcome to take care of it. 1.4
<L[redacted] Your to kind . :) 8.5 7.1
<m[redacted]s> Sure. :-) 8.5
<L[redacted]> Is the "presentation" due prior to the end of the project? - -1 1.7
<I[redacted]> I guess . . . do you know where my site is? 9.3

no points

Page difference -9

<m[redacted]> I think we could do what is called 'team building exercise' — 1.3
very soon. Like right now, perhaps? 1.7
<I[redacted]> Or if you want, we could wait till Scott is present. 2.10/9.1
> thats better
<ma[redacted]s> That's a good idea. M[redacted] got a bit depressed here. :-) 9.1
<m[redacted]> Just kidding. 9.6 7.1
> ....
<L[redacted]> :) — 8.5
<L[redacted]> The computers that any of you use . . . are they on campus or do 6.2
you have home computers?
> for chatting or?
<m[redacted]> Right now we're all in school. But we all have computers at 6.4
home, too.
<L[redacted]> What type or kind of connection? — 6.2
<m[redacted]s> We found it easier to start up when all are present here. 9.1
<L[redacted]> I've just got a measly little 28.8 connection due to my living 6.4
out in the sticks.
<L[redacted]> 28.8 modem that is.
> do you have homepages with some presentation of yourselves? 6.2
<m[redacted]> I got a T1, but most of us (like the other two) use modems. 6.4
<d[redacted]> Yes, we have homepages 6.4
8.1 > please give us the URL:s 6.2 — agreed, no point.
<L[redacted]> :) hehehehe I have friends that use Cable Modems. I do have a 6.4
site .. however, it doesn't go into to much detail about myself (I
know .. been there. :)) 8.1
<L[redacted]> http://www.csis.gvsu.edu/~[redacted] 6.4 — one phrase agreed, no point
<L[redacted]> the other's here will follow with ~username 6.4
> www.m[redacted].net 9.4 — agreed, no point
<m[redacted]> Hey, you got a strange color.... =) 8.5
<L[redacted]> To much sun :-) — 7.2
<m[redacted]> I guess so. 7.2 7.1 8.5 — agreed, no point
<L[redacted]> You want so see something rediculous . . . 7.2
<m[redacted]> :-) 8.5
<ma[redacted]> Sure...
<L[redacted]> go to my site . . > Favorites > Files-CSIS
<L[redacted]> Look at the .JPG file. — 7.2
<L[redacted]> That is an image of my first Drivers License
<A[redacted]> :D 8.5
<m[redacted]> Ok - now I got a better idea. I do hope the colors are 7.2
negative on your homepage by purpose.
*** i[redacted] (piotten@irchat-51421.telia.com) has joined channel &brio[redacted]
7.2 <L[redacted]> Yes. The state screwed up . . . I though t it was worth the
$6.00 to get a new one.
> jahaja
<i[redacted]> stabilt 7.2 — 1
<m[redacted]s> Otherwise, if they're negative only in my browser, I might 7.2
have offended you seriously...
<L[redacted] :) — 8.5
> piss off 7.2 — 1
<it[redacted]s> i'd like some spam, spam, spam, spam with spam. 7.2 — 1
<ma[redacted]> M[redacted] last comment was not directed at you americans, but at — 6.1
the moron it97uls...
<ma[redacted]s> ...who happens to be one of our classmates 6.1 — one phrase agreed, no point
<L[redacted] mattis may "give em de boot" 7.1
<i[redacted]> don't listen to that crap
<L[redacted] he is the channel "Operator" 6.1
<i[redacted]> i'm the supervisor of this whole project
<ma[redacted]s> How do I do that? 6.2 — 1/2
<L[redacted]> hang on . .
<i[redacted]err bll
*** i[redacted] has left channel &brio[redacted]
<m[redacted]> Uffe var tyst! 7.4 — 1
<m[redacted]> Okay - he left.

Page differences — 12

Deduct -2

> allright when the bug has left, do you want to see a pic of me? — 6.2
<d[redacted]> yes 6.4
> http://boes.org/gallery/photo25.html up in the left corner — 9.4
<L[redacted]> what is your client that your using? — 6.2
<m[redacted]> Well, our client is just called 'irc' and is probably a basic Unix feature. 9.4
<L[redacted]> it still should have some options to boot people — 9.1
<L[redacted]> did he leave or did he just go invisible? - 6.2
<m[redacted]> If you've viewed those pictures now, then you should now he is a few years older by now. He is a real prodigy. 7.1
<m[redacted]> He left,
<m[redacted]> i[redacted]s that is.
<L[redacted] (8) — 8.1
> by the way it's not obvious by the name that I'm male 6.1
<L[redacted] So is Ja[redacted] 6.4
<I[redacted]> (I[redacted] that is)
i[redacted]s tjena stefen
<L[redacted] you can type /whois [username] minus the brackettes 9.4
i[redacted]s du skriver meddelanden till mig med /msg i[redacted] <jättesnälla kommentarer här>
<m[redacted]> My homepage can be found at www.docs.uu.se/~[redacted] 9.4
-> *i[redacted]* glekrjkrjrkrjkrlewrerkjewr
<L[redacted] I am assuming A[redacted] is a female 6.2 ??? — 8.6
i[redacted]s just
<L[redacted] I went to school with an Annica. - 6.1 —1
<m[redacted]> There's a link there that says 'pictures'. I intended it to be a photo album, but I never completed it. 6.4
> a boy a[redacted]? 6.2
<A[redacted] Quite right.... :) — 8.1 6.4
<L[redacted] Just making sure.
<A[redacted]> I/
<m[redacted]> You never know, these days.
<L[redacted] Would it be to rude to ask what the age of everyone is . . . unless it is an irrelevent topic . . skip it. Just curious. 6.2
<m[redacted]> I don't look like that nowadays, I guess. 6.4 —1
<L[redacted]> J[redacted] => 25 6.4
> 28 6.4 agreed, no point
<m[redacted]> 24 on the 25th. 6.4
<A[redacted]> The same goes for me 6.4
<m[redacted]> A[redacted] is having trouble deciding. 7.1
<L[redacted] the it97### . . . is that when you enrolled at your university. 6.2
<m[redacted]> Yep.
<L[redacted] Indecisive huh? 7.1
<d[redacted] same m[redacted]
<L[redacted] I started at Grand Valley the fall of 96 . . . 6.1
<A[redacted]> They are very, very bad boys... :) — 8.5 7.2
<L[redacted] Anyone Married? — 6.2
> :) — 8.1
<L[redacted]> Kids?
<L[redacted]> Family
<I[redacted]> ? 6.2
<L[redacted]> Grand Children? — 7.1
<A[redacted]> No
<A[redacted]> No 6.4
<A[redacted]> No
agreed, no point
<L[redacted]> Great Grand Children 7.2
<L[redacted]> hehehehehehe
> a girlfriend and a cat 6.4
6.4
<L[redacted]> was that a yes m[redacted] — 6.2
<m[redacted]> He is the grandfather around here. — 7.2
> not married :) — 8.1
<L[redacted]> J[redacted]is.
<I[redacted]> Happily too. 6.4

Page differences - 4

6.4 – one phrase, agreed, no point

Delete 6

<L[redacted]> 2 kids.
<L[redacted]> 3 and 5
<m[redacted]> Impressive.
<L[redacted] As I stated earlier . . . time may be an issue. . . but doable. 6.8
<L[redacted]> Just need to communicate.
<m[redacted]> Sure. Nights are great for programming.
<L[redacted]> What are you guys using for Java? – 6.2
<m[redacted]> What we could do now is to try to find a time for meetings 9.1
that suits everybody.
<m[redacted]> What do you mean, 'for Java' ? A linux machine? – 6.2
<L[redacted]> well . . . S[redacted] indicated tomorrow . . 2.1
<L[redacted]> Um . . are you using JBuilder? 6.2
<L[redacted]> or just some command line tools. 6.4 –1 7.1
<m[redacted]> Nope. javac. More macho that way.
<m[redacted]> command line, that is.
<L[redacted] What JDK . . . I've been diong all my C and C++ programming 6.1/4.3
that way. Fell in love with an ascii text editor . . . found myself
being more productive with that then the fellow student(s) that used
TurboC and it's projects. –1
<A[redacted]> Visual J++ 6.4
<L[redacted]> However, recently, I have run into a little "issue" of not being 6.1
able to read in long file names in my editor so I snagged JBuilder.
<m[redacted]> Linux and emacs. Works great. JDK. 6.4
<L[redacted]> JDK . . I'm using 1.2.2 of Suns. – 6.4
<m[redacted]> So am I. 6.4
> me too 6.4
<L[redacted]> Annica? – 6.2
<A[redacted]> Going to install that too 6.4
<m[redacted]> d[redacted]? 6.2
<L[redacted]> GVSU has an IBM and the SUN available. 6.4 one phrase - agreed
<L[redacted]> If it is unanimous that we use Sun 1.2.2 then there "shouldn't" 6.4 no point
be an issue. I'd prefer Sun.
<m[redacted]> Sure.
<d[redacted]> I am using SUN in school 6.4
<L[redacted]> Of course i would . . . i have everything setup for it . . 6.1 –1
> I like the SUN in the sky – 7.1
> hate unix 6.1 –1
<m[redacted]> I think morgan has lost it. 7.2
<L[redacted]> Which . . you've not seen much of lately. 7.2 –1
<L[redacted]> correct?
<L[redacted]> What does m[redacted] like instead of unix? 6.2
<m[redacted]> He's running around like a maniac laughing. – 7.2
<m[redacted]> Did you say S[redacted] wanted a meeting tomorrow? – 2.1
<L[redacted]> I take it that all of you are in a computer lab? - 6.2
<L[redacted]> yes. 6.4
u[redacted]n stef
<m[redacted]> Yep. 6.4
<L[redacted] grr. hang on . . . clicked the wrong button...
> it's ok whith unix too, just kidding but I prefer to work in windows 6.1 agreed no point
<m[redacted]> Then we could perhaps go for the same bat time, same bat 7.4/2.2/2.1
channel? (:-) – 8.5
<L[redacted]> hmmmm He is suggesting 3:30 + 1 GMT Tuesday. 2.1
<m[redacted]> I mean the same time, same channel tomorrow? – 2.1
> ok for me 2.3
<A[redacted]> Fine 2.3 7.2
<m[redacted]> Seems I'm the only fan of 60's batman TV-series... Strange. ;-) 8.5
)
<L[redacted] Same time won't work . . we all (here) will be in the Brio 2.1 6.1
class.
<L[redacted]> We will be done at 4:15 – 6.1 same phrase as above – agreed, no point
<m[redacted]> Earlier? – 6.2
> zzzzzzzzzzzzzz – 7.1

Page differences – 11

Deduct[illegible] 6

<L[redacted]> IF the AM (our time) is preffered . . hmmm then I will need talk to my manager at work . . 6.1
<L[redacted] it is doable.
<L[redacted]> 3:30 GMT+1 — 2.1
<m[redacted]> Didn't you say you're class was moved until thursday? — 6.2
<L[redacted]> no . . . not the class ... the topic. — 6.4
<m[redacted]> ok.
> let's take tomorrow, it's ok 2.1
<m[redacted]> Tomorrow, then - 22:15 our time = 4.15 pm your time. — 2.1
<m[redacted]> Ok with everyone? — 3.5
<L[redacted] um . . If you want .. otherwise I can be here in the am. 2.1
<A[redacted]> Yep — 2.3
<d[redacted] Ok — 2.3
<L[redacted] :) 8.1
> i haven't went to sleep before 02.00 am this year - i like eavenings — 6.1
<ma[redacted]s> Actually, it would be fine by me - but then I'd be chatting fromhome. We all would. 6.1 6.4 2.3
<L[redacted] . . Home would be okay . . I might have to fine a Winblows IRC chat client . . . not a problem. My connection just isn't very fast. — 2.2 — 6.6
<m[redacted]> But you're using it right now, and it seems to work fine enough - to us, at least. 6.4
<L[redacted]> So we are agreed on 22:15 GMT + 1? — 2.1
<I[redacted]> no . . I am on campus right now. — 6.1
<I[redacted]> :) 8.1
8.6 <L[redacted]> BIG difference.
<I[redacted]> I've telneted into my account and run BitchX and it is SLOOOOWOWWW 6.6
8.6
<m[redacted]> No, not 22:15 GMT - no good. 4:15 your time. 2.1
<L[redacted] Either way . .
<L[redacted]> I'll figure out some way to get in and chat. — 6.6
<m[redacted]s> 21:15 gmt = 4:15EST. — 2.1 — agreed, no point
<L[redacted]> um . . . didn't I state 22:15 GMT+1 (8) — 8.1
<I[redacted]> oh .. it say GMT + 1
<I[redacted]> Tomorrow after class. — 2.1
<m[redacted]> Ok, now I get it... I misunderstood.
<L[redacted]> (for us.
<m[redacted]> Yup - see you tomorrow then. (Or write you, I suppose.) — 6.7
<L[redacted]> I'll be there. Now all we need to do is confirm with Scott. — 2.3
<m[redacted]s> You'll take care of that? — 6.2
<L[redacted]> Yes . . I'll e-mail him tonight. .. or this afternoon. — 6.4
<L[redacted]> For now it is in the afternoon.
> allright, see you tomorrow then — 6.3/6.7
<I[redacted]> evening. 6.3 one phrase
<L[redacted]> Night. 6.3 agreed, no point
<m[redacted]> Night here. 6.4
<L[redacted] depends on what you want to look at it from :) — 8.1
<d[redacted]> Night
> the SUN is black — 7.1
<m[redacted]> Couldn't agree more. Goodnight! — 6.3
<L[redacted]> Here . . the sun is gray. 7.2
<I[redacted]> (clouds) .
<L[redacted]> Night. 6.3
> cu — 6.3
<L[redacted]> Talk to you guys(gales) tomorrow. 6.3/6.7
*** Signoff: mattis (Quit: Leaving)
Page differences - 6
<A[redacted]> Bye then 6.3
<L[redacted]> Night. 6.3
*** L[redacted] has left channel &bri[redacted]
IRC log ended Mon Jan 31 22:21

Master copy - 198
Phrases
number of diff 42
156

Master Copy
Phrases - 198
Total deducted points 20.5
Total matched phrases 177.5

Deduct -0

IRC number 10

Team members:
[redacted]) [redacted]= (not present)
[redacted]) [redacted]= (not present)
[redacted]) [redacted]

IRC log started Thu Feb 24 14:34:31 2000
ùíù BitchX: Auto Response is set to - marsmans
ùíù Connecting to port 6667 of server csis.gvsu.edu [refnum 0]
-Brio.csis.gvsu.edu(***)- Looking up your hostname...
-Brio.csis.gvsu.edu(***)- Checking ident...
-Brio.csis.gvsu.edu(***)- Found your hostname
-Brio.csis.gvsu.edu(***)- Received ident response
ùíù BitchX: For more information about BitchX type /about
ùíù Welcome to the Brio IRC Network [redacted]
([redacted].csis.gvsu.edu) (from Brio.csis.gvsu.edu)
ùíù Your host is Brio.csis.gvsu.edu[turing.csis.gvsu.edu], running version Elite3.1 (from Brio.csis.gvsu.edu)
ùíù This server was created Thu Feb 17 2000 at 11 02:35 EST(from Brio.csis.gvsu.edu)
ùíù Brio.csis.gvsu.edu Elite3.1 oiwsghkcfrabexAOSNTCY biklmnopstvaxqRLKOA
ùíù [local users on irc(14)] 100%
ùíù [global users on irc(0)] 0%
ùíù [invisible users on irc(14)] 100%
ùíù [ircops on irc(0)] 0%
ùíù [total users on irc(14)]
ùíù [unknown connections(1)]
ùíù [total servers on irc(1)] (avg. 14 users per server)
ùíù [total channels created(3)] (avg. 4 users per channel)
ùíù Current Local Users [14] Max: [37]
ùíù Current Global Users [14] Max: [37]
ùíù MOTD File is missing
ùíù Mode change [+i] for user [redacted]
ùíù Mode change [+w] for user [redacted]
ùíù [redacted] [[redacted]gvsu.edu] has joined #[redacted]
ùíù Topic ([redacted]): milestone
ùíù Topic ([redacted]): set by mattis at Thu Feb 24 14:32:11 2000
ùíù [Users([redacted]3:3)]
[[redacted]] [[redacted]] [[redacted]]
ùíù Channel [redacted] was created at Thu Feb 24 14:30:06 2000
<S[redacted]> hi! 6.3 ✓
ùíù BitchX: Join to [redacted] was synced in 3.845 secs!!
<m[redacted]> hi! 6.3 ✓
<D[redacted]> hi 6.3 ✓
[redacted] H ~[redacted]
[redacted]3 [redacted]n H ~[redacted]
N[redacted])
[redacted] [redacted]s H@ [redacted]
<S[redacted] ja[redacted] went over to the job fair -2.10 ✓
<m[redacted]> You got a job fair right noe? 6.2 ✓
<m[redacted]> now?
<ma[redacted] that is.
ùíù m[redacted] [~it97[redacted]] has joined #bri[redacted]
<S[redacted]> yep 6.4 ✓
<m[redacted]> hoho
<D[redacted]> it just like you go to shop for a job. -7.1 ✓
<ma[redacted]> Welcome. 6.3 ✓
<m[redacted]> Yes, we got them too.
<ma[redacted]> Will he be here in time for the meeting? 6.2 ✓

Page difference - 0

<S[redacted]> yes 6.4 -1
<S[redacted]> w/ carl, not now - 2.10
<ma[redacted]> Ok, thats what I meant too.
<S[redacted]> has everyone looked at my milestone report? - 1.10
<m[redacted]> No - on the web? - 9.3
<S[redacted]> yest
<S[redacted]> yest
<S[redacted]> yes
<S[redacted]> :) - 8.1
<m[redacted]> =) - 8.1
ùíù SignOff [redacted]: #Brio[redacted] (Ping timeout)
ùíù m[redacted] [~[redacted]] has joined #brio[redacted]
<ma[redacted]> Now ping is messing with us again... 6.6
<S[redacted]> are you guys reading it? 9.3
<m[redacted]> yep
<D[redacted]> S[redacted]. Do we need to demonstrate to Carl in the other room. 4.9
<S[redacted]> yes
<m[redacted]> what are you actually reading? - 9.3
<S[redacted]> I was over there, but Eric kicked me off - 11.11
<S[redacted]> what do you mean, ~~morgan~~? - 9.3
<Dr[redacted]> He did. Why? 6.3 - agree, no points
<S[redacted]> to run the video server
<S[redacted]> he was testing - 11.11
<m[redacted]> you wrote: are you guys reading it?
<ma[redacted]> I am reading - nice to see C-code that is easy to read and well commented. Guess I shouldn't be reading it now, though. =) - 6.8 8.1
<S[redacted]> I meant the report and motor control program, m[redacted] - 9.4
<Dr[redacted]> Scott meant the milestone ~~report~~3 on the web:m[redacted] - 9.4
<m[redacted]> ok, just printing it out - 6.1 -1
<S[redacted]> I'm going to go over to the other lab. Be right back - 6.1
IRC log ended Thu Feb 24 14:42:02 2000

Page differences - 3

Master copy phrases - 27
Number of diff - 3
24

Master copy phrases - 27
Total deducted points - 2
Total matched phrases 25

(Test 1)   IC-2

Sample Emails for validation

Here's my submission. I have placed the category and sub-category at what I believe to be the end of the 'main' phrase however, there are situations where there is a category and sub-category within a phrase here I have parenthesised the category and sub-category. E.g. Have a GOOD (c.8.6) Weekend (c6.3)! The parenthesised category and sub-category is not the primary categorisation of the phrase but a subtle emphasis applicable to the primary category. I hope I've done the right thing…

mc Phrases-8
Tot. deducted-1
Tot Matched-7

```
Received: (qmail 26611 invoked by alias); 1 Feb 2000 12:29:49 -0000
Delivered-To: [redacted]
Received: (qmail 26608 invoked by uid 0); 1 Feb 2000 12:29:48 -0000
Received: from river.it.gvsu.edu (148.61.1.16)
  by csis.gvsu.edu with SMTP; 1 Feb 2000 12:29:48 -0000
Received: from localhost ([redacted])
      by river.it.gvsu.edu (8.8.6 (PHNE_17190)/8.8.6) with SMTP id
HAA23303
      for <[redacted] Tue, 1 Feb 2000 07:29:48 -0500 (EST)
Date: Tue, 1 Feb 2000 07:29:48 -0500 (EST)
From: [redacted]>
To: [redacted]
Subject: Times for meetings.
Message-ID: <Pine.HPP.3.95.1000201072543.21263D-
100000@river.it.gvsu.edu>
MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
```

Deduct -1

mc Phrases-8
No. diff-2
Tot. diff-6

Hello-6.3

The times over here are 6 hours behind 6.6 (2.1) Sweden time. Therefore, lets set a time to use. We can use Sweden time when we discuss what time to meet since there are four of us over there and only two over here.
Also, the only morning that works good for me is Tuesdays unless we meet at 11:00 Sweden ~~time or~~ 5:00AM EST which I don't have a problem with but John might 5.8 -1
One last thing. What programming experience does everybody 6.2 have?
Personally, I have not done any programming in Java but I have done a lot in c++. Please let me know.
4.3 (9.3) Thanks 6.3 - agreed no pts 4.5
[redacted]

```
Received: (qmail 23462 invoked by uid 0); 4 Feb 2000 14:18:39 -0000
Received: from eos10.csis.gvsu.edu ([redacted] 162.110)
  by turing.csis.gvsu.edu with QMQP; 4 Feb 2000 14:18:39 -0000
From: [redacted]
Date: Fri, 4 Feb 2000 09:18:38 -0500 (EST)
To: [redacted]
Subject: Re: Meeting time
In-Reply-To: <OFB8099A1A.F3F2D8F0-ON8525687B.004C7BDE@mailrouter.net>
Message-ID: <Pine.LNX.4.10.10002040912530.30358-
100000@eos10.csis.gvsu.edu>
```

-0 2

MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII

Hi everyone! 6.3

2.1

How would Wednesday, February 9, at 9:00 AM Michigan time work for 6.2 everyone? The only days I cannot meet in the morning next week are -6.1 Tuesday and Thursday. We got to get together and have a pow-wow! 7.1

(8.6)

Have a GOOD Weekend! 6.3

3.5 agreed no points

agreed no points

[redacted]

differences - 2

MC phrases - 7
No. of diff. - 2
Tot. diff. - 5

MC phrases - 7
Tot. deducted - 0
Tot. Matched 7

Deduct 375 -1

Sample IRC's (Internet Relay Chat) for validation

IRC number 1

Team members:
[redacted])
[redacted])
A[redacted])
[redacted]t)
[redacted]

IRC log started Mon Jan 31 21:29
*** Value of LOG set to ON
<L[redacted]> Given the "picture" of the surface, we are supposed to mimic the user's path by elevating the surface accordingly. 1.2 (1.3)
<L[redacted]> Um . . Not sure what else to say about it. NCS
<L[redacted]> Is this still making sence? 6.2
<m[redacted]> Certainly. NCS
*** Value of LOGFILE set to brio13
<L[redacted]> Does it make you cringe like it has for many people on this end? 7.1
<L[redacted]> hehehe
<m[redacted]> Our teacher, Arnold Pears, is probably still with you in Grand Valley - that's why we don't know much yet. - 4.10
<L[redacted]> still "with" us? - 6.2 (8.5) - agreed - no points
<L[redacted]> as in physically?
<m[redacted]> It doesn't seem to horrible. It'll take some time, I guess, but not impossible. - 6.8
<L[redacted]> No. definitely not impossible. 6.8 Time is the main issue. - 6.6
<L[redacted]> Your on a 10 week schedule (this is what I've been told) . . 4.10 if you started when we did that gives us 7 or 6 weeks to crank this out.
<m[redacted]> Well, in order to make use of time maximally we should try to divide all work carefully, so that we could work in parallell. 1.9
<L[redacted]> I would have thought that your instructor would have given you at least some inclination as to what this project is going to entail. 4.10
<m[redacted]> *checking calendar* NCS
<L[redacted]> When possible. There will obviously be times when that won't be possilble. NCS
<A[redacted]> We will have our first lecture next wednesday, I think. 4.10
<m[redacted]> That's when we'll get some more info... 4.10 (6.1)
<d[redacted]> We will know about the project in tomorrow 4.10
<L[redacted]> Erickson's site indicates that you'll find out about this next week. - 4.9
<m[redacted]> And from then, there's only five weeks *phew* 1.7 (8.5) - agreed - no points
<L[redacted]> .. Erickson had originally told us Tuesday but (4.9) now it is Thursday. 4.10
<L[redacted]> It keeps getting pushed back . . . and back . . .
<L[redacted]> Has your instructor said anything about the "introduction" of the fellow teammates? - 6.2
<m[redacted]> And the schedule gets tighter and tighter... 4.10
<L[redacted]> And they wonder why we stay up all night . . . 4.10
<A[redacted]> Only that we are supposed to a presentation in the form of a 'creative' :8.5 webpage 1.2
<m[redacted]> Well, our instructor is in Grand Valley... 6.4 :-) 8.1 But we got a piece of paper with some instructions. 4.10
<L[redacted]> Creative huh? 6.2 - agreed - no points
<L[redacted]k> :) 8.1
> can you distribute all info that you will be given on thursday? 9.1
<L[redacted]> How versed (yes I will do that 9.6) are you guys with HTML? 9.3
<L[redacted]> If you want I can post it off my site. 9.1
<L[redacted]> Or e-mail it .. how ever you preffer. 9.7
<m[redacted]> I could do something in case of emergency. But if you like, you're welcome to take care of it. - 1.4
<L[redacted]> Your to kind . :) 6.9 (8.5)
<m[redacted]> Sure. :-)
8.5

page differences - 6

Deduct

376

<L[redacted]> Is the "presentation" due prior to the end of the project? 1.7 (1.2)
<L[redacted]> I guess . . . do you know where my site is? 9.3
1.3 <m[redacted]> I think we could do what is called 'team building exercise' very soon. Like right now, perhaps? 1.7 (9.3) — agreed-no points
<L[redacted]> Or if you want, we could wait till S[redacted] is present. 9.1 (2.10)
> thats better 9.6
<ma[redacted]> That's a good idea. M[redacted] got a bit depressed here. (:-) (?) 8.5 -1
<ma[redacted]> Just kidding. 7.1 Joke agreed-no points
UNSURE ABOUT THE CONTENT OF THIS COMMENT...
> ....
<L[redacted]> :) (8.5)
<L[redacted]> The computers that any of you use . . . are they on campus or do you have home computers? 6.2
> for chatting or? (?)
<m[redacted]> Right now we're all in school. 6.4 But we all have computers at home, too.
<L[redacted]> What type or kind of connection? 6.2
<ma[redacted]> We found it easier to start up when all are present here. 9.4 — no points
<L[redacted]> I've just got a measly little 28.8 connection due to my living out in the sticks. 6.4
<L[redacted]> 28.8 modem that is.
> do you have homepages with some presentation of yourselves? 6.2
<m[redacted]> I got a T1, but most of us (like the other two) use modems. 6.4
agreed no points
<d[redacted]> Yes, we have homepages 6.4
> please give us the URL:s 6.2
8.5 <L[redacted]> :) hehehehe I have friends that use Cable Modems. 9.4 — agreed - no points I do have a site .. however, it doesn't go into to much detail about myself I know .. been there. :) 8.5 -1 6.4
-1 7.1
<L[redacted]> http://www.csis.gvsu.edu/~[redacted] 9.4
<L[redacted] the other's here will follow with ~username
> www.[redacted].net 9.4
<ma[redacted]> Hey, you got a strange color.... =) 7.1 (8.5) agreed-no points
<L[redacted] To much sun :) 7.2 (8.5)
<m[redacted]> I guess so. 7.2
<L[redacted]> You want so see something rediculous . . . 7.2
<ma[redacted]> :-) 8.5 agreed No points
<ma[redacted]> Sure... 7.2
<L[redacted]> go to my site . . > Favorites > Files-CSIS
<L[redacted]> Look at the .JPG file.
<L[redacted]> That is an image of my first Drivers License 7.2
<A[redacted]> :D 8.5
<m[redacted]> Ok - now I got a better idea. I do hope the colors are negative on your homepage by purpose. 7.2
*** i[redacted] (piotten@irchat-51421.telia.com) has joined channel &brio[redacted]
<L[redacted]> Yes. The state screwed up . . . I though t it was worth the $6.00 to get a new one. 7.2
> jahaja
<i[redacted]s> stabilt 7.2
<m[redacted]s> Otherwise, if they're negative only in my browser, I might have offended you seriously... 7.2
<L[redacted]> :) (8.5) agreed - no points
> piss off 7.2 (7.3) -1
<it[redacted]> i'd like some spam, spam, spam, spam with spam. 7.2
<m[redacted]> M[redacted] last comment was not directed at you americans, but at the moron it97uls... 6.1
-1 7.3
<m[redacted]s> ...who happens to be one of our classmates.
<L[redacted] mattis may "give em de boot" 7.1
<it[redacted]s> don't listen to that crap
<L[redacted]> he is the channel "Operator" 6.1
<i[redacted]> i'm the supervisor of this whole project
<ma[redacted] How do I do that? 6.2
<L[redacted]> hang on . .
<i[redacted]> err bll
*** i[redacted] has left channel &brio[redacted]

I'd like a copy of the photo, sounds like fun!

Page differences - 12

local humour no points

<m[redacted]> Uffe var tyst! - hmm m...
<m[redacted]> Okay - he left.
> allright when the bug has left, ~~do you~~ want to see a pic of me? - 6.2
<d[redacted]> yes - 6.4 7.3
> http://boes.org/gallery/photo25.html up in the left corner - 9.4
<L[redacted]> what is your client that your using? - 6.2
<m[redacted]s> Well, our client is just called 'irc' and is probably a basic Unix feature. - 9.4
<L[redacted]> it still should have some options to boot people - 9.1
<L[redacted]> did he leave or did he just go invisible? - 6.2
<m[redacted]> If you've viewed those pictures now, then you should now he is a few years older by now. He is a real prodigy. - 7.1
<m[redacted]> He left,
<m[redacted]> it97uls that is.
<L[redacted]> 8) 8.1
> by the way it's not obvious by the name that I'm male - 6.1
<L[redacted]> So is J[redacted].
<L[redacted]> ([redacted] that is) 6.4
i[redacted] tjena stefen
<L[redacted]> you can type /whois [username] minus the brackettes - 9.4
i[redacted]s ~~du skriver meddelanden till mig med~~ /msg it97uls <~~jättesnälla kommentarer~~ här>
<m[redacted]> My homepage can be found at www.docs.uu.se/~it97maf - 9.4
-> *i[redacted]s* glekrjkrjrkrjkrlewrerkjewr
<L[redacted]> I am assuming A[redacted] is a female. . ??? - 6.2 (7.1) - not joking - agreed no points
8.6
i[redacted]s just
<L[redacted]> I went to school with an A[redacted] - 6.1
<m[redacted]> There's a link there that says 'pictures'. I intended it to be a photo album, but I never completed it. - 6.4
> a boy annica? 6.2 (7.1) not joke - agreed - no points
<A[redacted]> Quite right. :) 6.4
<L[redacted]> Just making sure. (?) 8.1
<A[redacted]> I/ (?)
<m[redacted]> You never know, these days.
<L[redacted]> Would it be to rude to ask what the age of everyone is . . . 6.2 unless it is an irrelevent topic . . skip it. Just curious.
<m[redacted]> I don't look like that nowadays, I guess. - 6.4
<L[redacted]> J[redacted] => 25 - 6.4
> 28 - 6.4
<m[redacted]s> 24 on the 25th. - 6.4
<A[redacted]> The same goes for me - 6.4
<m[redacted]> A[redacted] is having trouble deciding. - 7.1
<L[redacted]> the it97### . . . is that when you enrolled at your university. - 6.2
<m[redacted]s> Yep.
<L[redacted]> Indecisive huh? 7.1
<d[redacted]> same m[redacted]s
<L[redacted]> I started at Grand Valley the fall of 96 . . . 6.1
<A[redacted]> They are very, very bad boys... :(- 8.5
<L[redacted]> Anyone Married? - 6.2 7.2
> :) - 8.1
<L[redacted]> Kids? 6.2
<L[redacted]> Family one pt ded w/above
<L[redacted]> ?
<L[redacted]> Grand Children? (6.2) - joke - no points
<A[redacted]> No
<A[redacted]> No 6.4
<A[redacted]> No
<L[redacted]> Great Grand Children (7.1) Part of the same joke - no points
<L[redacted]> hehehehehehe 7.2
> a girlfriend and a cat - 6.4
<L[redacted]> was that a yes morgan? - 6.2
<m[redacted]> He is the grandfather around here. - 7.2
> not married :) 8.1
6.4

Page differences - 6

6 Deduct 378 2

<L[redacted] J[redacted] is.
<L[redacted] Happily too. 6.4
<L[redacted] 2 kids.
<L[redacted] 3 and 5
<m[redacted]> Impressive.
<L[redacted] As I stated earlier . . . time may be an issue. . . but doable. — 6.8
<L[redacted] Just need to communicate.
<m[redacted]> Sure. Nights are great for programming. — 6.8 — agreed - no points
<L[redacted] What are you guys using for Java? — 6.2
<m[redacted]> What we could do now is to try to find a time for meetings that suits everybody. — 9.1 (2.1) -1
<m[redacted]> What do you mean, 'for Java' ? A linux machine? — 6.2
<L[redacted] well . . . Scott indicated tomorrow . . 2.1
<L[redacted]> Um . . are you using JBuilder? — 6.2
<L[redacted] or just some command line tools.
<m[redacted] Nope. javac. More macho that way. 6.4 (7.2) -1
<m[redacted]> command line, that is. no points
<L[redacted] What JDK . . . I've been diong all my C and C++ programming that way. Fell in love with an ascii text editor . . . found myself being more productive with that then the fellow student(s) that used TurboC and it's projects. 6.1 4.3
<A[redacted]> Visual J++ — 6.4
<L[redacted] However, recently, I have run into a little "issue" of not being able to read in long file names in my editor so I snagged JBuilder. 6.1
<m[redacted] Linux and emacs. Works great. JDK. — 6.4
<L[redacted] JDK . . I'm using 1.2.2 of Suns. — 6.4
<m[redacted]> So am I. — 6.4
> me too — 6.4
<L[redacted] A[redacted] 6.2
<A[redacted]> Going to install that too — 6.4
<m[redacted]> d[redacted]? — 6.2
<L[redacted] GVSU has an IBM and the SUN available. 6.4 — agreed - no points
<L[redacted] If it is unanimous that we use Sun 1.2.2 then there "shouldn't" be an issue. I'd prefer Sun.
<m[redacted]> Sure.
<dr[redacted] I am using SUN in school — 6.4
<L[redacted] Of course i would . . . i have everything setup for it . . . — 6.1
> I like the SUN in the sky — 7.1
> hate unix - 6.1
<m[redacted] I think morgan has lost it. — 7.2
<L[redacted]> Which . . you've not seen much of lately. 7.2
<L[redacted] correct?
<L[redacted]> What does morgan like instead of unix? — 6.2
<m[redacted]> He's running around like a maniac laughing. — 7.2
<m[redacted]> Did you say Scott wanted a meeting tomorrow? — 2.1
<L[redacted] I take it that all of you are in a computer lab? — 6.2
<L[redacted] yes.
u[redacted]n stef agreed / no points
<m[redacted]> Yep.
<L[redacted] grr. hang on . . . clicked the wrong button. . (?) 7.3
> it's ok whith unix too, just kidding but I prefer to work in windows — 6.1
<m[redacted] Then we could perhaps go for the same bat time, same bat — 7.1 (2.1)(2.2) channel? :-) — 8.5
<L[redacted] hmmmm He is suggesting 3:30 + 1 GMT Tuesday. — 2.1
<m[redacted] I mean the same time, same channel tomorrow? — 2.1
> ok for me 2.3
<A[redacted]> Fine 2.3
<m[redacted]> Seems I'm the only fan of 60's batman TV-series... Strange. 7.2 ;-) — 8.5
<L[redacted] Same time won't work . . we all (here) will be in the Brio class. — 2.1 — 6.1
<L[redacted] We will be done at 4:15
<m[redacted] Earlier? 6.2

Page differences — 6.

> zzzzzzzzzzzzzz -7.1
<L[redacted]> IF the AM (our time) is preffered 6.1 . . hmmm then I will need talk to my manager at work . .
<L[redacted]> it is doable.
<L[redacted]> 3:30 GMT+1 -2.1
<m[redacted]s> Didn't you say you're class was moved until thursday? -6.1 6.2 - agreed no points
<L[redacted]> no . . . not the class ... the topic. -6.4
<ma[redacted]> ok.
> let's take tomorrow, it's ok -2.1
<ma[redacted]> Tomorrow, then - 22:15 our time = 4.15 pm your time. -2.1
<m[redacted]> Ok with everyone? 2.1 - 3.5 - no points
<L[redacted]> um . . If you want .. otherwise I can be here in the am. -2.1
<A[redacted]> Yep -2.3 2.3 - agreed - no points
<d[redacted]> Ok
<Li[redacted]> :) 8.1 2.3 - agreed no points
> i haven't went to sleep before 02.00 am this year - i like eavenings -6.1
<m[redacted]> Actually, it would be fine by me - but then I'd be chatting fromhome. We all would. -6.1 (6.4)
<L[redacted]> . . Home would be okay . . I might have to fine a Winblows IRC chat client -2.2 . . not a problem. My connection just isn't very fast. -6.6
<m[redacted]> But you're using it right now, and it seems to work fine enough - to us, at least. -6.4
<L[redacted]> So we are agreed on 22:15 GMT + 1? -2.1
<L[redacted]> no . . I am on campus right now. -6.1
<L[redacted]> :) 8.5 8.6 8.1 - agreed - no points
<L[redacted]> BIG difference. -6.6
<L[redacted]> I've telneted into my account and run BitchX and it is SLOOOOWOWWW -8.6
<m[redacted]> No, not 22:15 GMT - no good. 4:15 your time. -2.1
<L[redacted]> Either way . .
<L[redacted]> I'll figure out some way to get in and chat -6.6
<m[redacted]> 21:15 gmt = 4:15EST. -6.6 (6.4) agreed - no points
<L[redacted]> um . . . didn't I state 22:15 GMT+1 8) -8.1
<L[redacted]> oh .. it say GMT + 1
<Li[redacted]> Tomorrow after class 2.1
<m[redacted]> Ok, now I get it... I misunderstood. agreed - no points
<I[redacted]> (for us. 2.1 -6.7
<m[redacted]> Yup - see you tomorrow then. (Or write you, I suppose.)
<L[redacted]> I'll be there. Now all we need to do is confirm with Scott. -2.3
<m[redacted]s> You'll take care of that? -6.2
<L[redacted]> Yes . . I'll e-mail him tonight. .. or this afternoon. -6.4
<L[redacted]> For now it is in the afternoon. agreed no points
> allright, see you tomorrow then -2.1 (6.3)
<L[redacted]> evening. -6.3
<I[redacted]> Night.
<m[redacted]s> Night here. -6.4
<L[redacted]> depends on what you want to look at it from :) 8.1
<d[redacted]> Night - 6.3 -1
> the SUN is black 7.1
<m[redacted]> Couldn't agree more. Goodnight! - 6.3
<L[redacted]> Here . . the sun is gray. -7.2
<Li[redacted]> (clouds) . not joke - no points
<I[redacted]> Night. - 6.3
> cu - 6.3 7.1
<L[redacted]> Talk to you guys(gales) tomorrow. - 6.3 (6.7)
*** Signoff: ma[redacted] (Quit: Leaving)
<Ar[redacted]> Bye then - 6.3
<L[redacted]> Night. - 6.3
*** L[redacted] has left channel &brio[redacted]
IRC log ended Mon Jan 31 22:21

mc phrases - 198
No. of diff - 40
158

mc phrases - 198
Tot. deduct - 10
Tot. matched 188

Page: differences - 10

380 Deduct

(-2)

IRC number 10

Team members:
[redacted]s)   [redacted] (not present)
[redacted])   [redacted]= (not present)
S[redacted])   [redacted]

IRC log started Thu Feb 24 14:34:31 2000
ùíù BitchX: Auto Response is set to - marsmans
ùíù Connecting to port 6667 of server csis.gvsu.edu [refnum 0]
-Brio.csis.gvsu.edu(***)- Looking up your hostname...
-Brio.csis.gvsu.edu(***)- Checking ident...
-Brio.csis.gvsu.edu(***)- Found your hostname
-Brio.csis.gvsu.edu(***)- Received ident response
ùíù BitchX: For more information about BitchX type /about
ùíù Welcome to the Brio IRC Network [redacted]
([redacted].csis.gvsu.edu) (from Brio.csis.gvsu.edu)
ùíù Your host is Brio.csis.gvsu.edu[turing.csis.gvsu.edu], running version Elite3.1 (from Brio.csis.gvsu.edu)
ùíù This server was created Thu Feb 17 2000 at 11 02:35 EST(from Brio.csis.gvsu.edu)
ùíù Brio.csis.gvsu.edu Elite3.1 oiwsghkcfrabexAOSNTCY biklmnopstvaxqRLKOA
ùíù [local users on irc(14)] 100%
ùíù [global users on irc(0)] 0%
ùíù [invisible users on irc(14)] 100%
ùíù [ircops on irc(0)] 0%
ùíù [total users on irc(14)]
ùíù [unknown connections(1)]
ùíù [total servers on irc(1)] (avg. 14 users per server)
ùíù [total channels created(3)] (avg. 4 users per channel)
ùíù Current Local Users [14] Max: [37]
ùíù Current Global Users [14] Max: [37]
ùíù MOTD File is missing
ùíù Mode change [+i] for user [redacted]
ùíù Mode change [+w] for user [redacted]
ùíù [redacted]
ùíù Topic ([redacted]): milestone
ùíù Topic (#[redacted]): set by mattis at Thu Feb 24 14:32:11 2000
ùíù [Users(#[redacted]:3)]
[[redacted]] [[redacted]] [[redacted]]
ùíù Channel #[redacted] was created at Thu Feb 24 14:30:06 2000
<S[redacted]> hi! – 6.3
~~ùíù BitchX: Join to [redacted] was synced in 3.845 secs!!~~
<ma[redacted]s> hi! – 6.3
<D[redacted]> hi – 6.3
~~#[redacted] [redacted] H ~n[redacted]~~
~~[redacted])~~
~~#[redacted]3 I[redacted] H ~[redacted]~~
~~[redacted])~~
~~#[redacted] [redacted]s H@ [redacted]~~
<S[redacted] j[redacted] went over to the job fair 2.10 (6.1) (–1)
<ma[redacted]> You got a job fair right noe? – 6.2
<ma[redacted]> now?
<ma[redacted]> that is.
~~ùíù mo[redacted] [~[redacted]om] has joined [redacted]~~
<S[redacted] yep – 6.4
<mo[redacted]> hoho
<D[redacted]> it just like you go to shop for a job. – 7.1
<m[redacted]> Welcome. – 6.3
<ma[redacted]> Yes, we got them too. – 6.4 (–1)
<ma[redacted]> Will he be here in time for the meeting? – 6.2

Page difference - 2

<S[redacted]> yes -6.4
<S[redacted]> w/ carl, not now -2,10
<m[redacted]> Ok, thats what I meant too.
<S[redacted] has everyone looked at my milestone report? 1.10 (1.7) - agreed - no points
<m[redacted] No - on the web? -9.1 - 9.3 - no points
<S[redacted] yest
<S[redacted] yest 6.4 -1
<S[redacted] yes
<S[redacted]> :) -8.1
<m[redacted]> =) -8.5 -8.1 - no points
ùÿù SignOff m[redacted]: [redacted] (Ping timeout)
ùÿù m[redacted]
<m[redacted]> Now ping is messing with us again... - 6.6
<S[redacted]> are you guys reading it? -9.3
<m[redacted] yep- 9.7 - no points
<D[redacted] Scott: Do we need to demonstrate to Carl in the other room. -4.9
<S[redacted]> yes
<m[redacted]> what are you actually reading? -9.3
<S[redacted] I was over there, but F[redacted] kicked me off -11.11
<S[redacted] what do you mean, m[redacted]? -9.3 agreed no points
<D[redacted]> He did. Why? -6,2
<S[redacted]> to run the video server 6.4 (11.11)
<S[redacted]> he was testing 8.1 - no points
<m[redacted] you wrote: are you guys reading it?
<m[redacted] I am reading - nice to see C-code that is easy to read and well commented. Guess I shouldn't be reading it now, though. =) 8.5 6.8
<S[redacted]> I meant the report and motor control program, m[redacted] -9.4
<D[redacted]h> S[redacted] meant the milestone report3 on the web:m[redacted] -9.4
<m[redacted] ok, just printing it out -6.4 -6.1 - no points - agreed
<S[redacted] I'm going to go over to the other lab. Be right back -6.1
IRC log ended Thu Feb 24 14:42:02 2000

Page differences - 8

mc phrases -27
No. of diff -10
17

mc phrases -27
Tot deduct. -3
Tot. matched 24

Appendix 4.7 Team Profile for Eight Teams

PERSONAL

CODE	INFORMATION	HI	LI	H2	L2	H3	L3	H4	L4
Team Info	Team No.	HI	LI	H2	L2	H3	L3	H4	L4
Uni. Files	Gender	1F – 5M	2F – 3M	1F – 4M	1F – 5M	1F – 4M	2F – 4M	2F – 4M	3F – 3M
Uni. Files	Age range	21-25	23-48	20-26	22-25	20-30	22-26	21-28	22-41
Team Info	Team size	6	5	5	6	5	6	6	6
Sec 3.1 TP	Team grade (Ave.)	4.83 TAM	3.06 TAM	4.86 TAM	3.56 TAM	4.94 TAM	3.67 TAM	4.89 TAM	3.8 TAM
PL (Duration)	Team total work hours on project	272hrs 55min	240hrs 50min	59hrs 20min	84hrs	171hrs 30min	129hrs 35min	251hrs 55min	347hrs 50min
QSD – Q9	Team total work hours outside project	17hrs	11hrs	20hrs	24hrs	18hrs	19hrs	21hrs	21hrs
QSD – Q6	Team course load (in number of classes)	21 courses	13 courses	22 courses	20 courses	24 courses	17 courses	21 courses	17 courses
Sec 4 Coded Communication	Team communication in percentage – i.e. Number of emails, IRC etc.	IRC 88% Email 12%	IRC 64% Email 36%	IRC 88% Email 12%	IRC 90% Email 10%	IRC 61% Email 39%	IRC 76% Email 24%	IRC 86% Email 14%	IRC 76% Email 24%

TEAM WORK EXPERIENCE

CODE	INFORMATION	H1	L1	H2	L2	H3	L3	H4	L4
QSB – Q3	Team previous experience in team working.	1=0, 2=3, 3=15	1=0, 2=2, 3=10	1=0, 2=4. 3=10	1=0, 2=3, 3=15	1=0, 2=4, 3=8	1=1, 2=3, 3=14	1=0, 2=4, 3=13	1=0, 2=3, 3=12
QSB – Q2	Team percentage of time working alone	58%	59%	66%	50%	87%	67%	68%	50%
QSB – Q2	Team percentage of time working with other(s)	42%	41%	34%	50%	13%	33%	32%	50%
QSB – Q6	Team self-classification of roles ie. all leaders? (Only count of 4-more than…)	3-ideas, 2-explain, 1-askI, 1-askE, 2-listen, 3-sum, 3-lead, 2-do	1-ideas, 1-explain, 1-askE, 2-listen, 1-do	2-ideas, 3-explain, 2-askE, 2-lead, 2-do	3-ideas, 1-listen, 1-sum, 1-notes, 2-lead, 3-do	2-ideas, 1-explain, 1-askI, 2-askE, 2-listen, 1-lead, 2-do	1-ideas, 1-explain, 1-notes, 1-lead, 1-do	3-ideas, 4-explain, 1-resolve, 1-askI, 2-askE, 1-listen, 4-sum, 3-lead, 1-do	1-askI, 1-askE, 2-listen, 1-sum, 1-lead, 2-do
PE	Actual team roles	1 off leader, 1 lead help even work	1 off leader uneven wk	1 off leader even work	1 off leader 2 non-wrkrs uneven wk	1 off leader 1 lead help even work	1 off leader even work	1 off leader 1 non-wrkr uneven wk	1 abs lead 1 act lead, 2 non-wrkrs
QSB – Q8 & Q9	Team opinion about working in teams (% of positive and negative)	Pos 54% Neg 46%	Pos 53% Neg 47%	Pos 56% Neg 44%	Pos 58% Neg 42%	Pos 53% Neg 47%	Pos 46% Neg 54%	Pos 57% Neg 43%	Pos 55% Neg 45%
QSD – Q1	Team goals	9	7	10	6	6	8	9	8
J1	Team initial impressions of team members.	Pos=10 Neg=2	Pos=5 Neg=1	Pos=2 Neg=1	Pos=8 Neg=2	Pos=13 Neg=4	Pos=14 Neg=5	Pos=11 Neg=5	Pos=6 Neg=6
J3 – Q9	Team final impressions of team members.	Pos=4 Neg=3	Pos=2 Neg=3	Pos=4 Neg=1	Pos=2 Neg=1	Pos=1 Neg=1	Pos=5 Neg=0	Pos=2 Neg=1	Pos=4 Neg=2
QSB – Q7	Team characteristics.	4-intro, 4-think, 4-anal, 6-calm, 5-easy, 4-avoid, 4-expect, 5-quiet, 5-end	3-doer, 3-intuitive, 3-anal, 3-easy, 3-expect, 3-end	3-practical, 4-extro, 3-doer, 4-method, 5-anal, 4-calm, 4-easy, 3-tolerant, 4-want, 3-quiet, 3-begin	4-practical, 4-extro, 4-doer, 4-intuitive, 4-anal, 4-easy, 4-tolerant, 4-want, 4-talk, 4-end	3-practical, 4-doers, 3-method, 3-anal, 3-calm, 3-expect, 4-talk, 3-end	5-practical, 6-doers, 4-anal, 4-calm, 5-easy, 5-tolerant, 5-want, 4-quiet, 4-end	4-extro, 4-think, 4-anal, 4-easy, 4-want, 4-talk	4-practical, 3-intro, 4-doer, 3-method, 4-anal, 3-calm, 4-easy, 3-avoid, 3-expect, 3-quiet, 4-end

CMC EXPERIENCE

CODE	INFORMATION	H1	L1	H2	L2	H3	L3	H4	L4
QSA – Q1	Team total previous use of CMC	1=17, 2=4, 3=7	1=14, 2=2, 3=4	1=16, 2=4, 3=5	1=7, 2=10, 3=13	1=7, 2=7, 3=6	1=18, 2=5, 3=7	1=11, 2=12, 3=7	1=17, 2=1, 3=7
QSA – Q2	Team total range of familiarity with CMC	1=15, 2=2, 3=5, 4=2, 5=6	1=15, 2=0, 3=0, 4=1, 5=4	1=16, 2=2, 3=2, 4=1, 5=4	1=4, 2=4, 3=5, 4=7, 5=10	1=9, 2=1,3=4, 4=1, 5=5	1=14, 2=2, 3=8, 4=1, 5=5	1=10, 2=5, 3=6, 4=2, 5=7	1=9, 2=6, 3=0, 4=3, 5=7
J3 – Q6	Team total opinion on success of CMC work	7.8	7.8	6.8	6.3	8.2	7.4	10	7.75%
PL	Team percentage of actual use of artificial media	20%	44%	42%	57%	46%	37%	50%	51%

CS EXPERIENCE

CODE	INFORMATION	H1	L1	H2	L2	H3	L3	H4	L4
TBE	Team total CS experience. Known languages	23	Unknown	20	25	17	23	20	21
QSC – Q1 Part 1	Team total opinion of self-knowledge in CS (Part 1)	1=10, 2=34, 3=10	1=9, 2=25, 3=2	1=17, 2=23, 3=5	1=8, 2=28, 3=18	1=11, 2=18, 3=7	1=23, 2=22, 3=9	1=20, 2=30, 3=4	1=23, 2=23, 3=0
PE	Team total opinion of contribution of CS	13, 14, 14, 19, 19, 21	13, 16, 19, 26, 26	16, 18, 19, 23, 24	12, 13, 18, 19, 19, 20	16, 17, 21, 23, 23	10, 13, 13, 20, 20, 25	13, 16, 16, 18, 18, 19	8, 12, 15, 19, 21, 25

EXPECTATIONS

CODE	INFORMATION	H1	L1	H2	L2	H3	L3	H4	L4
QSD – Q7	Team total personal expectations of hours	17hrs	12hrs	11hrs	14hrs	8hrs	18hrs	21hrs	13hrs
QSD – Q8	Team total expectations of group work	64%	53%	60%	50%	53%	47%	63%	59%
QSC – Q1 Part 3	Team total expectations of needed knowledge	1=11, 2=35, 3=8	1=13, 2=21, 3=2	1=19, 2=21, 3=5	1=12, 2=28, 3=14	1=20, 2=11, 3=5	1=32, 2=15, 3=7	1=24, 2=26, 3=4	1=24, 2=21, 3=0

CODE KEY

QSA, QSB, QSC, QSD = Questionnaire Sections A-D
TBE = Team Building Exercise
J1, J2, J3 = Interval Logs (Journals) 1, 2, 3

PL = Project Log
PE = Peer Evaluation

Appendix 5.1 Level of significance for a two-tailed Chi-Square test

Critical Values of χ^2 at Various Levels of Probability (Coolican, 1999)

Df	0.20	0.10	0.05	0.02	0.01	0.001
1	1.64	2.71	3.84	5.41	6.64	10.83
2	3.22	4.60	5.99	7.82	9.21	13.82
3	4.64	6.25	7.82	9.84	11.34	16.27
4	5.99	7.78	9.49	11.67	13.28	18.46
5	7.29	9.24	11.07	13.39	15.09	20.52
6	8.56	10.64	12.59	15.03	16.81	22.46
7	9.80	12.02	14.07	16.62	18.48	24.32
8	11.03	13.36	15.51	18.17	20.09	26.12
9	12.24	14.68	16.92	19.68	21.67	27.88
10	13.44	15.99	18.31	21.16	23.21	29.59
11	14.63	17.28	19.68	22.62	24.72	31.26
12	15.81	18.55	21.03	24.05	26.22	32.91
13	16.98	19.81	22.36	25.47	27.69	34.53
14	18.15	21.06	22.68	26.87	29.14	36.12
15	19.31	22.31	25.00	28.26	30.58	37.70
16	20.46	23.54	26.30	29.63	32.00	39.29
17	21.62	24.77	27.59	31.00	33.41	40.75
18	22.76	25.99	28.87	32.35	34.80	42.31
19	23.90	27.20	30.14	33.69	36.19	43.82
20	25.04	28.41	31.41	35.02	37.57	45.32
21	26.17	29.62	32.67	36.34	38.93	46.80
22	27.30	30.81	33.92	37.66	40.29	48.27
23	28.43	32.01	35.17	38.97	41.64	49.73
24	29.55	33.20	36.42	40.27	42.98	51.18
25	30.68	34.38	37.65	41.57	44.31	52.62
26	31.80	35.56	38.88	42.86	45.64	54.05
27	32.91	36.74	40.11	44.14	46.96	55.48
28	34.03	37.92	41.34	45.42	48.28	56.89
29	35.14	39.09	42.69	49.69	49.59	58.30
30	36.25	40.26	43.77	47.96	50.89	59.70
32	38.47	42.59	46.19	50.49	53.49	62.49
34	40.68	44.9	48.60	53.00	56.06	65.25
36	42.88	47.21	51.00	55.49	58.62	67.99
38	45.08	49.51	53.38	57.97	61.16	70.70
40	47.27	51.81	55.76	60.44	63.69	73.40
44	51.64	56.37	60.48	65.34	68.71	78.75
48	55.99	60.91	65.17	70.20	73.68	84.04
52	60.33	65.42	69.83	75.02	78.62	89.27
56	64.66	69.92	74.47	79.82	83.51	94.46
60	68.97	74.40	79.08	84.58	88.38	99.61

Appendix 5.2 Level of significance for a two-tailed Spearman's Rho test

Critical Values of Spearman's Rho (Coolican, 1999)

	0.10	0.05	0.02	0.01
n=4	1.000			
5	0.900	1.000	1.000	
6	0.829	0.886	0.943	1.000
7	0.714	0.786	0.893	0.929
8	0.643	0.738	0.833	0,881
9	0.600	0.700	0.783	0,833
10	0.564	0.648	0.745	0.794
11	0.536	0.618	0.709	0.755
12	0,503	0.587	0.671	0,727
13	0,484	0.560	0.648	0.703
14	0.464	0.538	0.622	0.675
15	0.443	0.521	0.604	0,654
16	0.429	0.503	0.582	0.635
17	0.414	0.485	0,566	0.615
18	0.401	0.472	0.550	0.600
19	0.391	0.460	0.535	0.584
20	0.380	0.447	0.520	0,570
21	0.370	0.435	0.508	0.556
22	0.361	0.425	0.496	0,544
23	0.353	0.415	0,486	0.532
24	0.344	0.406	0,476	0,521
25	0.337	0.398	0,466	0,511
26	0.331	0.390	0.457	0,501
27	0.324	0.382	0.448	0.491
28	0.317	0,375	0.440	0.483
29	0.312	0.368	0.433	0,475
30	0.306	0.362	0.425	0.467

Appendix 5.3 Teams' Organised Communication

Team H1 - High Performing Team - IRC 10 - p. 28	
1	<p> So, whats on the agenda for this meeting?
1	<J> Let's ask our team leader...
	Ùíù □BitchX□:Now logging messages to: /home/eb/.BitchX/BitchX.away ð B is away: (Auto-Away after 10 mins) [□BX□-MsgLog On] ùíù You have been marked as being away
2	<C> Have our Swedish team half browsed thrue our design proposal? <C> Have our US team half browsed thrue the swedish design proposal?
2	<p> yes
2	<J> Yes. A bit more detailed than ours.
2	<C> But they were quite equal...
2	<J> Yes
2	<D> C> Is your page down? I can't browse it
2	<J> I can reach it.
2	<C> It should be up
2	<D> C> Don't mind. Now it's rockin' again :-)
2	<C> The page is now up at our runeH1 account www.csis.gvsu.edu/~runeH1
2	<A> I just browsed through the documentation. Looking good!
3 2	<BE> As we speak, I am trying to make a brief page about the RMI thing. <BE> I think we should use that for the GameServer and the client. I have some code working that basically does what we want to do in general.
3	<D> That's great B
2	<C> I think that we should write the server in Java. C is faster but JAVA is going to be more beneficial
2	<BE> Also, we no longer have to support "hot pluggable" navication code. This will simplify things.
2	<C> We don't have to.....but if we want to, it can still be done if we use JAVA RMI <C> http://java.sun.com/docs/books/tutorial/rmi/overview.html <C> Nice RMI ovweview.html
2 4	<p> Any ideas on how to queue multiple clients? <p> Does anyone have any preferences as to what part they want to work on?
2	<BE> I would like to extend the java gameserver/client - to flesh out the RMI stuff.
4	<C> We have basically 4 parts to work on now <C> Server, client, motor control and video processor
4	<J> I don't mind working on the graphical interface of the client.
4	<C> Ok cool...
4	<A> I don't mind that either....
4	<p> B and I can do the game server
4	<C> D> You and me on the video thing?
4	<BE> The interface between the game server and client will need to be specified.
4	<D> OK! Video processing is interesting allright.
4	<C> Cool <C> So B and E will work on the Game Server
3	<BE> http://www.csis.gvsu.edu/~runeH1/rmi/rmi.html
4	<C> J and A works on the client.
3	<BE> If you want to see how easy it is to do, check out the code there.

Team L3 - Low Performing Team - IRC 24 - p.53	
1	<sm> I have a small meeting agenda posted on the runeL3 web-site. <sm> It's just some issues that I think we might want to discuss? <sm> it's waiting for you at the usual documents page.
1	<e> ok, see it
	Ùíù P_ [P@du41-3.ppp.algonet.se] has joined #brioL3
2	<sm> /who
2	<P> Hi again, some problems!!!
2	<sm> Yeah, you're in twice.
2	<P> I lost the connection
3	<sm> Anyway, what do you think of using cvs?
3	<P> Do we need it now?
4	<e> can you log in?
	Ùíù SignOff P: #brioL3 (Ping timeout)
4	<sm> i can't login yet.
4	<e> *laugh* <e> there goes p's ghost
5	<P> My friend has left the conversation
3	<sm> do you think we need to do version control?
6	<P> J has made a nice website ~runeL3brioL3
6	<e> ok <e> where?
6	<P> look at it now! <P> www.csis.gvsu.edu/~runeL3/brioL3
6	<e> wah
7	<sm> K is doing next week's report.
6	<e> nice =)
6	<sid> pretty snazzy P
6	<P> Everythig isn't completed yet but...
6	<sm> very nice website. why don't you make it our primary web-site.
6	<P> ok if that is ok for everyone
6	<b> :)
6	<Sid> you get my vote
6	<sm> mine too.
6	<P> If you click on the news-link, you can add or look at brioL3 news. <P> password is beerL3
	Ùíù You have new email.
1	<e> ok, let's get back to the meeting?
8	<sm> when can we see your video/camera code?
8	<P> Thursday evening <P> Thursday afternoon for you
9	<sm> we will set up next meeting time if necessary before the reprot is due after we work with the code.
9	<P> ok

Team H4 - High Performing Team - IRC 3 p.10	
1	<S> so, what should we each plan on doing this week/ weekend?
2	<J> ... I'll pull the stuff together later this evening.
1	<M> What's in the calendar?
1	J is hitting the comm control and the motor stuffs.
1	<M> (next week, that is)
1	<J> Ah .. good point. <J> Design document
1	<S> the link is dead, what does he expect for that?
1	<M> So I noted.
1	<J> hagn on.. there are two sites... <J> http://www.csis.gvsu.edu/class/brio/Management/assess.html
2	<mn> there is a directory called "work" in the runeH4 home, put the

	server stuff there, J
1 2	<J> http://www.csis.gvsu.edu/class/brio/BrioProject/Calendar.html <J> I can do that.
2	<mn> thanks
1	<J> Presntly the Design Document is first and foremost. <J> Makes me wish I remembered more of last semester's class ;)
1	<S> what is actually due for the design document? Our layout of the Java Applet? The diagram that M stepped us through?????????
1	<J> That. . .I am not sure about. <J> An overall break down of the "system" components ...
1	<M> Could be, I guess... But I would like to see what that link would show if it was working.
1	<mn> think so
1	<S> Well, I'll talk to E tomorrow when I schedule the meeting for the afternoon. I'll ask him then what he wants us to do <S> I'll e-mail you in the late morning then, too
1	<mn> we can put something together that shows and discusses the interaction b/w all components more in details
1	<M> What I think we would need to do (listening to last years students) would be to be very careful about how we specify all our objects and functions - to make sure they will work together once we put them together.
1	<S> I've heard that too...Is that what we need to have done by next week?
1	<M> I guess that is one thing a design document should contain - but then again - it depends on what is meant by a design document.
1	<J> you can't get to that site? <J> Also, I assume you want the motor control in C++ and not in C??
1	<M> From http://www.csis.gvsu.edu/class/brio/BrioProject/Calendar.html there is a link that says dd_guidelines but it doesn't work. <M> Apparantly the page is not there.
1	<J> Ahh.. I see. <J> So we should wait on that a bit huh.? <J> OH>>>!!!!
1	<M> I guess so. Well, I think both C++ and see can be easily integrated into Java. <M> J? OH>>>???? =)
3	<J> Can we setup a Common meeting time that stays the same? .. or is that not a good thing with your schedules? <J> :) <J> ehehehe <J> Smart @#$@
3	<mn> that would be great
3	<S> does 3 pm EST - 9 o'clock Swede time on Tuesdays work for everyone?
3	<mn> I think it's the only way to get this meeting problem solved
3	<J> You guys would prefer ... or say .. am us and pm sweden
3	<M> Perfect.

Team L4 - Low Performing Team - IRC 5 p.5

1	<M> jg□:□ good...hey once a gets here I'm going to point him to the report..then I'll probably ask each of you to say a little bit about what you've worked on this week, ok?
2	<H> are you guys in the US aware that we have an exam in like 10 days and that at least I will spend most of my time next week studying for that.
1 3	<jg> oki sounds oki <jg> E...which week did we tried the old program?
2	<P> No
3	<jg> "OLD"

3	<e> don't remember... <e> about two weeks ago maybe
2	<H> but that's the way it is...and I won't let anything else become more important than that exam... :-)
3	<jg> two weeks..hmm time flies..
3	<e> I have been getting it to run as non-root user also, and modified some code
3 4	<jg> nice <jg> H..are you still alive?
5	<M> I'm looking at A's schedule coming up here...how about we plan the rest of the meetings right now?
4	<H> yes...I am alive
6	<P> E, I am logged into a but I do not see you
5	<jg> sounds good M
2	<H> did anyone copy what I just said?
5	<M> He's got next week Wed. available at 17:00
6	<P> I get a nickname not registered yet, what does that mean?
7	<jg> H...i think we can update the applet a lot "på någe vis"
	[msg(P] /join a again
2	<P> H□:□ Yes I copied what you said.
2	<H> P: great... :-) and I hope you understand?!
5	<M> is there anyone for whom that does not work?
	Ùíù A [~a@DH05.DoCS.UU.SE] has joined #brioL4
5	<jg> i have a empty slot Wed 17.00..:)
8	<P> Hi a
5	<e> M: I suppose that's swedish time
5	<M> yes
	>>> Inviting A to #a
5	<H> for me....the later the better
	Ùíù □BitchX□: You are now talking to channel #brioL4
8	<e> join a a
	Ùíù □BitchX□: You are now talking to channel #a
8	<jg> hello A
	<Arnold> done
8	<H> hej a.
	Ùíù SignOff P #brioL4 (BR.Quit: P has no reason)
8	<e> hejsan A
8	<M> Hey a...the report is on our page under Reports/Report 3
	<Arnold> Hej, hur är det? Mycket job! Ùíù P [~j@eosH4.csis.gvsu.edu] has joined #a <Arnold> Going there now
8	<H> A, alldeles för mycket jobb. :-)

	Team L1 - Low Performing Team - IRC 1 - p.3/4
1	'k' :o} LOL! Time to get to work, before we meet with Arnold have we havent' accomplished anything.
2	'b' Did he show you what a circle looked look on the board?
3	'F' I think we all should come up with some suggestions about how to devide up the work, and perhaps send the suggestions by mail som we could study them. How does that sound?
2	'F' Yes and the circle wasn't nice...
4	'F' Malin has joined us.
4	'b' Hello Malin.
4	'N' not having a computer
4	'F' ... but left again.
5	'k' Has everyone got their interview done? I guess that is what has to be done this week. It would have had to be done sooner, but our GOOD csis emial server wasn't doing its job.
5	'N' I guess I have to write about myself since i have no partner
6	'b' Hey, is our meeting with Arnold supposed to be over NetMeeting?

5	'F' Malin has finished her work about you Brian.
6	'F' We suggested IRC.
6	'F' Is that OK?
6	'b' Good, I don't want to have to wrangle with NetMeeting.
7	'k' Arev you guys good at Math and Calculus? It been quite a while since I have had it (about 27 years or so.) I think the video and expecially the motor needs someone with good math knowledge.
7	'F' OK, that's good to know.
7	'N' We had our calculus exams two years ago, so they are relative fresh.
7	'F' I personally think the navigation will be the trickiest part writing.
8	'k' Does anyone know of someone who graduated last year, so we can borrow their code? By the way I do know that 2+2=5. New math!
4	'F' Malin is back...again
4	'N' AAAHHHH!
8	'F' Yes we know a couple of people.
9	'b' I think the navigation will be tricky, especially because of the play in the motor drive mechanism.
9	'F' Yes that's right.
10	'F' Which part do you guys think we should start with?
8	'k' We don't want to keep their code, just borrow it for a couple of months. We'll give it back at the end of March. Just a slight bit worn.
8	'F' I think that would be OK with them.
10	'b' I would guess just establishing the video would be our first step.
10	'F' OK
10	'F' I think the motor part would be quite easy...
11	'b' Have you guys played with the device yet?
12	'F' Which language should we use for the different parts?
11	'N' No
11	'F' No..
12	'F' I think C would be quicker for the low level stuff!
12	'F' ...but then again JAVA is easier with client - server stuff.
12	'b' Carl strongly recommended Java for all of it. I think you're right about C, but for its lack of security, Carl recommends Java.
12	'F' OK let's stick to JAVA then.
13	'k' According to the 'Assessment Guidlines' that Prof. Erickson has on his website first we have Team Setup - done. Next Design and specs, followed by Motor control, Video processing, Server, Navigation/integration, and Client.
	Team L2 - High Performing Team - IRC 30 - p.13/14
1	<D> Sug: did Cark tell u that we need to be int he lab this time?
1	<p> u need to be here in the lab with us
1	<D> I am at home, I didnt get yo email until now
1	<p> Carl wants all of us here.....
1	<D> Forget it now, it will take me 30 min to get there
1	<p> well...i think we have time.....dont we?
1	<D> We have 15 min
1	<D> Are u at the lab?
1	<p> yes......
1	<p> ok Dmitri....i guess its fine!
1	<D> Oh, how did u find out that we need to be at the lab?
2	<D> Oh, by the way, my journal is on the web
3	<M> hey guile.. i have a question about the motor_client stuff...you see that when you use the function extreme()... you send the ball to all the 4 corners.. ok.. but you send it to (0,0)

	(150,0) (0,150) (150,150).... but shouldn't the '150' be 210..??
3	<M> to get the extreme??
4	<g> Maube Mic, where did you find that code ?
5	<g> Kevin: is the board free ?
5	<g> I really need to test that...
4	<M> on our acount..
6	<K> Gigi: I opened Gcam.....and found the correct settings for that board so that all that shows up is the ball...everything else is black. I set it in the params file...so we should get a better reading now.
6	<g> thanks guy !
5	<K> Gigi: No the board is taken......
4	<M> guile: motor_client.c... line :154 ->
7	<D> Hey Kev: did u decide to go with one look or two for scanning the image?
7	<K> Dmitri□:□ two....there was only a .0001 sec difference
7	<D> Kev: ok, not a big difference
5	<K> GUys.....I have a free board....go to seos10
8	<U> guile: you copied the driver code to resources/milestone4/ ?
8	<g> NNo it is not ready...
8	<U> okay.
8	<U> what's the source file name
9	<M> hey guys... I need to restart my computer... I'll be right back...OK !!
9	<p> ok michael.....
9	<M> cool
9	Ùíù SignOff Michael: #brio9 (BR.Quit: Leaving)
10	<K> Gigi: The camera on seos10 is free
10	<U> woho.
10	<U> try try try
5	<K> let me reset the params for that board.
5	<g> ok.
11	<U> kevin: is that videod.c file in public_html/resources/milestone4/ up-to-date?
12	<p> the changes should be in his directory.....
	Team H2 High Performing Team - IRC 16 - p. 1536/1537
1	<l> As I said before we give RMI the rest of this week and then move on
2	<d> this is our final full week of working on it isn't it?
2	<l> I guess.
2	<R> next week is our final full week. We present the final demo in two weeks
2	<d> oh ok
1	<P> so what do we have to do in detail?
2	<l> I didn't realise you meant the project as a whole, John. Sorry.
2	<d> its ok :-)
1	<l> Integrate the part that we have so far.
1	<e> how's the idea on this weeks report look?
1	<e> as an idea of how the whole system works?
1	<R> It looks good to me. Do we need a navigator GUI?
1	<e> not necesellri, we just wanted to see if the nav did anything
3	<P> so when can I expect to hear about a game server implementation that can test navigation (this wouldn't necessarily have to communicate but accept fake input)?
1	<e> the navigation algorithm is intended to go into the Navigator
3	<e> Then it is ready to test "locally"
1	<e> the motor and video should be integrated in the Navigator too

1	<R> So you need a java class (or 2) that you can call for the navigator?
1	<R> Peter, do you have motor control in java?
1	<P> well, the navigation is not really a class, it's a loop that needs to bentegrated in the game server main loop
1	<P> rick: yes
1	<e> yes, the idea is we could basically put your videoapplet and the motordriver class into the navigator
1	<l> Well, we have thougt of the navigator as a separate class.
1	<R> Would it be a thread?
1	<e> The navigation algorithm is intended to go in an inner class to the Navigator which is a thread, so it can be executed by itself
1	<e> the inner class is a thread that is
1	<R> So the game server can start the navigation and then never worry about it until it is done?
1	<e> does that sound reasonable?
1	<R> works for me. And who is doing all this? Erik and Lotta?
1	<e> rick: The server starts the Navigaor and makes sure only one client is executing at a time
1	<R> Right! :)
1	<l> And the navigation calls an algoritm that is doing the stuff.
1	<e> Then gives a path to the navigator, which tells the server when it's done
1	<P> is there any stub I can use?
1	<l> So that we can change the algoritm easily if we want.
1	<P> inner classes considered harmful
1	<R> Will the server then act as a queue for incoming requests?
1	<P> the problem is that you can't "call" an algorithm
	Team H3 - High Performing Team - IRC 3 - p.17/18
1	[16:05] <J> So the user name is "brio10" and the password is "br10io" ... gotcha.
1	[16:05] <J> Oh yeah...
1	[16:05] <e> ok
2	[16:05] <J> Patrick: The navigator object is INSIDE the Game Server object. At least in our design...
2	[16:06] <J> The "maze server"...
2	[16:06] <J> is just a way of wrapping up the low level stuff with a Java interface.
2	[16:06] <J> (per your email question)
1	[16:06] <T> the user name is rune10 and password br10io
2	[16:06] <p> i don't think the navigator should be part of the game server, in my mind...
2	[16:06] <J> Ahh shit. Ok. Thanks.
2	[16:06] <J> Why?
2	[16:06] <a> maze is just to talk java and c with sockets
2	[16:06] <p> i think there are two primary responsibilities: 1) manage the game, 2) make movement decisions
2	[16:06] <J> It handles "game activity"...
2	[16:07] <J> Including setting up people...
2	[16:07] <p> well, the whole thing is game activity if you look at it that way
2	[16:07] <J> So we have a "game manager" object in the Game Server.
2	[16:07] <a> the game server should have the navigation
2	[16:07] <J> I don't think we need to have a whole different server for just queing players do we?
2	[16:07] <a> nop
2	[16:07] <p> so everytime someone makes a new game request, the current one is going to have to stop paying attention to the board unless we multithread it.

2	[16:08]	<J>	... pondering....
2	[16:08]	<T>	that sounds complicated
2	[16:08]	<J>	No we won't multithread. Not worth the effort.
2	[16:08]	<p>	well, not too complicated really...
2	[16:08]	<p>	threads are simple in java
2	[16:08]	<p>	it's a matter of the game server saying 'player1.start()'
2	[16:08]	<a>	you can queue-up people at a socket can't you?
2	[16:09]	<J>	Ok... well if they are simple in Java then maybe its a possibility...
2	[16:09]	<T>	but sequencing isn't
2	[16:09]	<J>	WE COULD ...
2	[16:09]	<J>	As you say, have a seperate little server... ABOVE the game server that just handles queing the players.
2	[16:09]	<p>	that is what i called the 'game server'
2	[16:09]	<J>	Then the game server reacts with only the active player blah blah..
2	[16:09]	<J>	Oh ok.
2	[16:09]	<J>	I guess its just how define the words then...
2	[16:09]	<p>	most other groups (last year too) had something separate in their diagram called "navigator"
2	[16:10]	<J>	It didn't "mean" that to me.
2	[16:10]	<J>	Its just a technicality then. ... No biggy.
2	[16:10]	<J>	So we can have a seperate server for the queing of players then?
2	[16:10]	<a>	we should be able to rip out the navigator right?
2	[16:10]	<p>	i figured it made the most sense for one java server queues players, and then makes an RMI call to the navigator when it wants a player to 'go'
2	[16:11]	<J>	I agree Patrick.
2	[16:11]	<a>	ok
2	[16:11]	<e>	sounds good

Appendix 5.4 All Teams' Sub-Category Data

Team H1 Sub-Categories Over Time												
Category 1 - Planning work												
Week	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	
Period 1	0	16	18	19	1	0	7	4	12	4	14	
Period 2	0	7	3	15	0	0	9	7	2	20	20	
Period 3	1	4	3	25	2	0	15	12	7	21	30	
Category 2 - Planning admin												
Week	**C2.1**	**C2.2**	**C2.3**	**C2.4**	**C2.5**	**C2.6**	**C2.7**	**C2.8**	**C2.9**	**C2.10**		
Period 1	17	2	18	3	5	0	0	0	0	2		
Period 2	11	5	6	0	6	2	0	3	0	5		
Period 3	20	6	6	2	11	5	0	0	0	6		
Category 3 - Decisions												
Week	**C3.1**	**C3.2**	**C3.3**	**C3.4**	**C3.5**	**C3.6**						
Period 1	7	4	4	2	12	9						
Period 2	3	1	8	0	0	0						
Period 3	0	1	3	1	4	14						
Category 4 - Roles												
Week	**C4.1**	**C4.2**	**C4.3**	**C4.4**	**C4.5**	**C4.6**	**C4.7**	**C4.8**	**C4.9**	**C4.10**		
Period 1	4	10	1	0	3	0	6	7	4	0		
Period 2	0	18	0	0	4	0	12	3	10	0		
Period 3	6	10	0	1	4	0	16	7	7	0		
Category 5 - Conflict												
Week	**C5.1**	**C5.2**	**C5.3**	**C5.4**	**C5.5**	**C5.6**	**C5.7**	**C5.8**	**C5.9**	**C5.10**		
Period 1	0	0	0	0	0	0	0	1	0	0		
Period 2	1	0	0	0	0	0	0	1	0	0		
Period 3	0	0	0	0	0	0	0	0	0	0		
Category 6 - Social/Get to Know												
Week	**C6.1**	**C6.2**	**C6.3**	**C6.4**	**C6.5**	**C6.6**	**C6.7**	**C6.8**	**C6.9**			
Period 1	36	9	58	17	2	9	20	13	2			
Period 2	17	6	92	32	0	14	44	31	9			
Period 3	40	24	126	58	23	26	55	75	16			
Category 7 - Humour												
Week	**C7.1**	**C7.2**	**C7.3**	**C7.4**								
Period 1	17	11	0	0								
Period 2	32	41	0	0								
Period 3	58	56	0	6								
Category 8 - Graphical Expressions												
Week	**C8.1**	**C8.2**	**C8.3**	**C8.4**	**C8.5**	**C8.6**	**C8.7**					
Period 1	15	0	0	0	9	6	1					
Period 2	56	0	1	0	22	3	6					
Period 3	74	0	2	0	39	19	11					
Category 9 - Ideas												
Week	**C9.1**	**C9.2**	**C9.3**	**C9.4**	**C9.5**	**C9.6**	**C9.7**					
Period 1	25	4	28	31	0	20	8					
Period 2	20	0	40	46	0	8	0					
Period 3	39	0	73	64	1	13	1					
Category 10 - Identification												
Week	**C10.1**	**C10.2**	**C10.3**									
Period 1	1	7	3									
Period 2	0	1	0									
Period 3	4	1	1									
Category 11 - Task/Work Specific												
Week	**C11.1**	**C11.2**	**C11.3**	**C11.4**	**C11.5**	**C11.6**	**C11.7**	**C11.8**	**C11.9**	**C11.10**	**C11.11**	**C11.12**
Period 1	0	0	4	0	0	0	0	1	0	0	0	0
Period 2	13	2	20	0	6	2	29	45	14	3	0	19
Period 3	30	3	9	2	8	0	23	26	50	18	8	50
Category 12 - Goals												
Week	**C12.1**	**C12.2**										
Period 1	0	0										
Period 2	0	0										
Period 3	3	0										

Team L1 Sub-Categories Over Time

Category 1 - Planning work

Week	C1.1	C1.2	C1.3	C1.4	C1.5	C1.6	C1.7	C1.8	C1.9	C1.10	C1.11
Period 1	2	6	28	37	5	1	8	1	32	6	13
Period 2	0	8	14	17	3	0	10	2	5	7	12
Period 3	1	0	1	5	0	0	2	4	5	5	16

Category 2 - Planning admin

Week	C2.1	C2.2	C2.3	C2.4	C2.5	C2.6	C2.7	C2.8	C2.9	C2.10
Period 1	27	5	15	4	5	5	2	0	24	1
Period 2	18	5	15	8	0	1	1	0	16	0
Period 3	14	1	12	4	1	0	2		23	7

Category 3 - Decisions

Week	C3.1	C3.2	C3.3	C3.4	C3.5	C3.6
Period 1	6	0	6	6	12	16
Period 2	0	1	0	0	7	0
Period 3	0	0	0	0	0	0

Category 4 - Roles

Week	C4.1	C4.2	C4.3	C4.4	C4.5	C4.6	C4.7	C4.8	C4.9	C4.10
Period 1	10	5	7	0	17	4	8	2	23	6
Period 2	2	2	0	0	5	0	4	1	12	0
Period 3	1	4	0	0	3	2	4	0	5	0

Category 5 - Conflict

Week	C5.1	C5.2	C5.3	C5.4	C5.5	C5.6	C5.7	C5.8	C5.9	C5.10
Period 1	3	1	0	0	1	0	0	1	0	1
Period 2	0	0	0	0	0	0	0	0	0	0
Period 3	2	0	0	0	0	0	0	1	0	0

Category 6 - Social/Get to Know

Week	C6.1	C6.2	C6.3	C6.4	C6.5	C6.6	C6.7	C6.8	C6.9
Period 1	13	11	58	16	5	12	8	19	7
Period 2	5	8	52	12	2	0	6	15	5
Period 3	6	0	36	1	8	1	16	11	6

Category 7 - Humour

Week	C7.1	C7.2	C7.3	C7.4
Period 1	47	86	12	3
Period 2	15	16	0	0
Period 3	0	0	0	0

Category 8 - Graphical Expressions

Week	C8.1	C8.2	C8.3	C8.4	C8.5	C8.6	C8.7
Period 1	3	0	0	0	11	12	0
Period 2	2	0	0	0	2	0	0
Period 3	0	0	0	0	0	0	0

Category 9 - Ideas

Week	C9.1	C9.2	C9.3	C9.4	C9.5	C9.6	C9.7
Period 1	16	0	76	40	3	21	3
Period 2	12	0	41	25	0	3	0
Period 3	9	0	13	6	1	2	5

Category 10 - Identification

Week	C10.1	C10.2	C10.3
Period 1	1	3	0
Period 2	0	1	0
Period 3	0	0	0

Category 11 - Task/Work Specific

Week	C11.1	C11.2	C11.3	C11.4	C11.5	C11.6	C11.7	C11.8	C11.9	C11.10	C11.11	C11.12
Period 1	0	0	0	1	2	0	2	7	0	0	0	2
Period 2	4	1	2	0	2	0	2	4	1	0	1	14
Period 3	9	0	3	0	1	0	2	7	17	3	6	8

Category 12 - Goals

Week	C12.1	C12.2
Period 1	1	2
Period 2	2	1
Period 3	0	0

Team H2 Sub-Categories Over Time

Category 1 - Planning work

Week	C1.1	C1.2	C1.3	C1.4	C1.5	C1.6	C1.7	C1.8	C1.9	C1.10	C1.11
Period 1	0	20	16	22	2	0	5	0	13	2	0
Period 2	1	13	110	49	13	0	12	2	4	14	19
Period 3	0	6	8	21	0	0	9	1	6	7	6

Category 2 - Planning admin

Week	C2.1	C2.2	C2.3	C2.4	C2.5	C2.6	C2.7	C2.8	C2.9	C2.10
Period 1	42	0	11	1	4	2	0	0	39	0
Period 2	59	0	22	17	20	30	8	0	63	0
Period 3	31	0	13	1	6	4	0	1	78	1

Category 3 - Decisions

Week	C3.1	C3.2	C3.3	C3.4	C3.5	C3.6
Period 1	0	2	2	1	3	7
Period 2	2	7	1	6	3	2
Period 3	0	0	0	1	1	2

Category 4 - Roles

Week	C4.1	C4.2	C4.3	C4.4	C4.5	C4.6	C4.7	C4.8	C4.9	C4.10
Period 1	8	0	7	0	10	1	7	1	21	11
Period 2	6	1	7	0	5	0	12	2	41	5
Period 3	6	2	1	0	6	0	2	2	37	1

Category 5 - Conflict

Week	C5.1	C5.2	C5.3	C5.4	C5.5	C5.6	C5.7	C5.8	C5.9	C5.10
Period 1	3	0	0	0	0	0	0	1	0	1
Period 2	8	5	0	2	0	0	4	5	2	3
Period 3	9	3	0	1	0	0	1	5	0	0

Category 6 - Social/Get to Know

Week	C6.1	C6.2	C6.3	C6.4	C6.5	C6.6	C6.7	C6.8	C6.9
Period 1	18	23	36	18	3	26	9	10	10
Period 2	19	46	80	33	12	42	12	36	7
Period 3	8	11	46	11	23	28	8	19	10

Category 7 - Humour

Week	C7.1	C7.2	C7.3	C7.4
Period 1	16	11	0	1
Period 2	12	6	2	2
Period 3	7	3	0	0

Category 8 - Graphical Expressions

Week	C8.1	C8.2	C8.3	C8.4	C8.5	C8.6	C8.7
Period 1	7	0	2	0	3	0	0
Period 2	58	10	1	0	4	2	4
Period 3	46	4	0	0	3	0	6

Category 9 - Ideas

Week	C9.1	C9.2	C9.3	C9.4	C9.5	C9.6	C9.7
Period 1	25	0	67	57	0	18	0
Period 2	79	0	130	70	7	28	0
Period 3	28	0	76	63	1	8	0

Category 10 - Identification

Week	C10.1	C10.2	C10.3
Period 1	1	0	2
Period 2	2	0	0
Period 3	0	0	0

Category 11 - Task/Work Specific

Week	C11.1	C11.2	C11.3	C11.4	C11.5	C11.6	C11.7	C11.8	C11.9	C11.10	C11.11	C11.12
Period 1	0	0	0	0	0	0	0	0	0	0	0	0
Period 2	6	2	1	1	1	0	9	12	11	1	16	10
Period 3	30	6	4	3	6	3	22	37	26	1	12	17

Category 12 - Goals

Week	C12.1	C12.2
Period 1	0	8
Period 2	0	0
Period 3	0	1

Team L2 Sub-Categories Over Time												
Category 1 - Planning work												
Week	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	
Period 1	0	32	155	67	1	2	16	12	29	6	15	
Period 2	0	27	50	100	0	0	33	14	10	33	98	
Period 3	0	21	21	68	11	10	33	8	18	25	57	
Category 2 - Planning admin												
Week	**C2.1**	**C2.2**	**C2.3**	**C2.4**	**C2.5**	**C2.6**	**C2.7**	**C2.8**	**C2.9**	**C2.10**		
Period 1	46	18	18	14	47	17	16	7	25	6		
Period 2	81	4	12	20	42	39	8	9	48	18		
Period 3	54	5	10	13	23	6	4	5	44	13		
Category 3 - Decisions												
Week	**C3.1**	**C3.2**	**C3.3**	**C3.4**	**C3.5**	**C3.6**						
Period 1	9	1	10	2	10	11						
Period 2	3	1	13	0	5	5						
Period 3	1	1	7	0	7	9						
Category 4 - Roles												
Week	**C4.1**	**C4.2**	**C4.3**	**C4.4**	**C4.5**	**C4.6**	**C4.7**	**C4.8**	**C4.9**	**C4.10**		
Period 1	64	4	5	4	17	2	25	9	44	15		
Period 2	48	6	6	4	21	4	20	9	55	3		
Period 3	43	2	0	4	16	0	14	2	56	0		
Category 5 - Conflict												
Week	**C5.1**	**C5.2**	**C5.3**	**C5.4**	**C5.5**	**C5.6**	**C5.7**	**C5.8**	**C5.9**	**C5.10**		
Period 1	18	6	0	1	0	0	1	7	2	2		
Period 2	43	5	0	5	3	0	20	28	1	0		
Period 3	97	16	0	2	2	13	14	7	0	0		
Category 6 - Social/Get to Know												
Week	**C6.1**	**C6.2**	**C6.3**	**C6.4**	**C6.5**	**C6.6**	**C6.7**	**C6.8**	**C6.9**			
Period 1	64	40	137	40	12	76	23	77	11			
Period 2	154	105	272	93	34	53	32	82	45			
Period 3	108	120	211	111	34	42	24	59	27			
Category 7 - Humour												
Week	**C7.1**	**C7.2**	**C7.3**	**C7.4**								
Period 1	71	65	0	6								
Period 2	125	191	11	3								
Period 3	77	119	1	4								
Category 8 - Graphical Expressions												
Week	**C8.1**	**C8.2**	**C8.3**	**C8.4**	**C8.5**	**C8.6**	**C8.7**					
Period 1	84	1	12	0	35	78	4					
Period 2	174	9	19	0	63	125	10					
Period 3	89	10	6	0	60	74	8					
Category 9 - Ideas												
Week	**C9.1**	**C9.2**	**C9.3**	**C9.4**	**C9.5**	**C9.6**	**C9.7**					
Period 1	87	1	220	212	18	70	1					
Period 2	82	3	239	192	12	25	0					
Period 3	73	2	175	154	0	16	0					
Category 10 - Identification												
Week	**C10.1**	**C10.2**	**C10.3**									
Period 1	0	6	2									
Period 2	2	2	3									
Period 3	0	0	1									
Category 11 - Task/Work Specific												
Week	**C11.1**	**C11.2**	**C11.3**	**C11.4**	**C11.5**	**C11.6**	**C11.7**	**C11.8**	**C11.9**	**C11.10**	**C11.11**	**C11.12**
Period 1	1	0	0	4	0	0	0	0	2	0	2	1
Period 2	65	9	22	8	16	8	27	84	55	10	19	69
Period 3	44	3	28	0	10	6	37	42	82	4	8	44
Category 12 - Goals												
Week	**C12.1**	**C12.2**										
Period 1	2	0										
Period 2	16	7										
Period 3	19	13										

Team H3 Sub-Categories Over Time												
Category 1 - Planning work												
Week	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	
Period 1	0	9	19	17	1	0	11	0	18	2	8	
Period 2	0	7	50	36	1	1	11	9	7	4	24	
Period 3	1	10	10	23	0	0	18	7	9	15	16	
Category 2 - Planning admin												
Week	**C2.1**	**C2.2**	**C2.3**	**C2.4**	**C2.5**	**C2.6**	**C2.7**	**C2.8**	**C2.9**	**C2.10**		
Period 1	101	20	17	19	8	5	4	10	32	2		
Period 2	33	4	15	3	4	1	3	1	50	6		
Period 3	18	3	4	4	5	1	1	0	41	0		
Category 3 - Decisions												
Week	**C3.1**	**C3.2**	**C3.3**	**C3.4**	**C3.5**	**C3.6**						
Period 1	3	0	5	3	3	4						
Period 2	2	2	14	9	1	14						
Period 3	0	0	0	1	0	0						
Category 4 - Roles												
Week	**C4.1**	**C4.2**	**C4.3**	**C4.4**	**C4.5**	**C4.6**	**C4.7**	**C4.8**	**C4.9**	**C4.10**		
Period 1	13	1	11	0	10	1	9	2	27	14		
Period 2	9	6	5	3	12	0	10	2	60	7		
Period 3	15	7	0	1	3	0	5	3	28	4		
Category 5 - Conflict												
Week	**C5.1**	**C5.2**	**C5.3**	**C5.4**	**C5.5**	**C5.6**	**C5.7**	**C5.8**	**C5.9**	**C5.10**		
Period 1	1	0	1	0	0	0	0	0	1	0		
Period 2	8	0	0	1	1	0	2	5	1	4		
Period 3	11	2	0	0	0	0	1	8	0	5		
Category 6 - Social/Get to Know												
Week	**C6.1**	**C6.2**	**C6.3**	**C6.4**	**C6.5**	**C6.6**	**C6.7**	**C6.8**	**C6.9**			
Period 1	18	11	61	36	2	22	11	22	10			
Period 2	13	9	85	25	1	13	8	22	4			
Period 3	4	6	92	21	7	10	11	37	11			
Category 7 - Humour												
Week	**C7.1**	**C7.2**	**C7.3**	**C7.4**								
Period 1	15	5	2	3								
Period 2	29	28	1	7								
Period 3	15	9	0	1								
Category 8 - Graphical Expressions												
Week	**C8.1**	**C8.2**	**C8.3**	**C8.4**	**C8.5**	**C8.6**	**C8.7**					
Period 1	24	1	4	0	11	26	0					
Period 2	30	1	5	0	24	32	0					
Period 3	44	4	13	0	10	23	4					
Category 9 - Ideas												
Week	**C9.1**	**C9.2**	**C9.3**	**C9.4**	**C9.5**	**C9.6**	**C9.7**					
Period 1	25	4	25	36	0	7	2					
Period 2	40	9	58	37	4	12	0					
Period 3	17	2	51	33	1	4	0					
Category 10 - Identification												
Week	**C10.1**	**C10.2**	**C10.3**									
Period 1	2	9	2									
Period 2	1	0	1									
Period 3	4	3	0									
Category 11 - Task/Work Specific												
Week	**C11.1**	**C11.2**	**C11.3**	**C11.4**	**C11.5**	**C11.6**	**C11.7**	**C11.8**	**C11.9**	**C11.10**	**C11.11**	**C11.12**
Period 1	0	0	0	0	0	0	0	0	0	0	5	0
Period 2	9	3	3	1	1	0	3	7	6	1	1	7
Period 3	33	5	7	0	15	0	25	50	24	11	4	17
Category 12 - Goals												
Week	**C12.1**	**C12.2**										
Period 1	1	1										
Period 2	3	3										
Period 3	6	1										

Team L3 Sub-Categories Over Time												
Category 1 - Planning work												
Week	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	
Period 1	0	20	52	24	1	1	8	5	11	5	5	
Period 2	0	15	46	32	5	2	11	2	10	8	22	
Period 3	0	5	13	35	1	1	4	0	1	15	16	
Category 2 - Planning admin												
Week	**C2.1**	**C2.2**	**C2.3**	**C2.4**	**C2.5**	**C2.6**	**C2.7**	**C2.8**	**C2.9**	**C2.10**		
Period 1	29	13	7	9	6	5	2	2	27	2		
Period 2	38	3	3	15	16	12	1	1	67	6		
Period 3	50	0	19	15	2	6	5	2	56	13		
Category 3 - Decisions												
Week	**C3.1**	**C3.2**	**C3.3**	**C3.4**	**C3.5**	**C3.6**						
Period 1	7	1	6	3	4	10						
Period 2	2	0	4	3	2	1						
Period 3	0	1	2	4	1	5						
Category 4 - Roles												
Week	**C4.1**	**C4.2**	**C4.3**	**C4.4**	**C4.5**	**C4.6**	**C4.7**	**C4.8**	**C4.9**	**C4.10**		
Period 1	7	1	2	0	6	0	2	4	11	0		
Period 2	9	6	0	1	8	0	4	0	22	2		
Period 3	11	0	0	0	6	1	9	2	7	0		
Category 5 - Conflict												
Week	**C5.1**	**C5.2**	**C5.3**	**C5.4**	**C5.5**	**C5.6**	**C5.7**	**C5.8**	**C5.9**	**C5.10**		
Period 1	5	1	0	0	0	0	0	2	0	0		
Period 2	12	1	0	0	0	0	2	2	2	0		
Period 3	13	3	0	0	2	0	0	7	1	0		
Category 6 - Social/Get to Know												
Week	**C6.1**	**C6.2**	**C6.3**	**C6.4**	**C6.5**	**C6.6**	**C6.7**	**C6.8**	**C6.9**			
Period 1	31	39	58	32	0	22	4	8	14			
Period 2	40	26	93	30	6	30	13	33	20			
Period 3	38	37	95	29	11	15	12	23	28			
Category 7 - Humour												
Week	**C7.1**	**C7.2**	**C7.3**	**C7.4**								
Period 1	10	5	1	0								
Period 2	16	4	2	5								
Period 3	13	14	0	0								
Category 8 - Graphical Expressions												
Week	**C8.1**	**C8.2**	**C8.3**	**C8.4**	**C8.5**	**C8.6**	**C8.7**					
Period 1	30	0	1	0	2	14	1					
Period 2	55	4	7	0	4	8	9					
Period 3	45	3	2	0	1	16	13					
Category 9 - Ideas												
Week	**C9.1**	**C9.2**	**C9.3**	**C9.4**	**C9.5**	**C9.6**	**C9.7**					
Period 1	49	9	42	48	3	11	0					
Period 2	48	5	74	44	6	21	2					
Period 3	29	0	57	58	0	13	0					
Category 10 - Identification												
Week	**C10.1**	**C10.2**	**C10.3**									
Period 1	0	5	4									
Period 2	0	4	0									
Period 3	0	2	2									
Category 11 - Task/Work Specific												
Week	**C11.1**	**C11.2**	**C11.3**	**C11.4**	**C11.5**	**C11.6**	**C11.7**	**C11.8**	**C11.9**	**C11.10**	**C11.11**	**C11.12**
Period 1	0	0	0	0	0	0	0	0	0	0	1	0
Period 2	21	4	6	4	6	1	20	43	33	6	8	29
Period 3	34	4	15	2	7	4	20	31	35	5	2	20
Category 12 - Goals												
Week	**C12.1**	**C12.2**										
Period 1	0	0										
Period 2	2	1										
Period 3	2	2										

Team H4 Sub-Categories Over Time												
Category 1 - Planning work												
Week	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	
Period 1	0	28	77	49	7	4	8	1	7	3	9	
Period 2	0	23	88	50	6	6	5	12	8	20	45	
Period 3	0	7	6	22	1	7	12	6	2	12	25	
Category 2 - Planning admin												
Week	**C2.1**	**C2.2**	**C2.3**	**C2.4**	**C2.5**	**C2.6**	**C2.7**	**C2.8**	**C2.9**	**C2.10**		
Period 1	57	8	34	11	8	6	4	0	11	7		
Period 2	31	5	20	20	20	20	6	1	72	7		
Period 3	25	2	5	6	7	8	4	1	38	5		
Category 3 - Decisions												
Week	**C3.1**	**C3.2**	**C3.3**	**C3.4**	**C3.5**	**C3.6**						
Period 1	0	3	3	1	18	10						
Period 2	7	3	8	8	9	18						
Period 3	1	0	2	3	2	0						
Category 4 - Roles												
Week	**C4.1**	**C4.2**	**C4.3**	**C4.4**	**C4.5**	**C4.6**	**C4.7**	**C4.8**	**C4.9**	**C4.10**		
Period 1	6	0	5	2	13	2	12	4	30	17		
Period 2	17	2	0	1	30	1	11	3	39	11		
Period 3	5	2	2	0	3	1	5	2	15	0		
Category 5 - Conflict												
Week	**C5.1**	**C5.2**	**C5.3**	**C5.4**	**C5.5**	**C5.6**	**C5.7**	**C5.8**	**C5.9**	**C5.10**		
Period 1	7	1	0	0	0	2	3	5	0	0		
Period 2	18	4	0	0	3	2	7	13	0	0		
Period 3	7	2	0	0	0	0	1	3	0	0		
Category 6 - Social/Get to Know												
Week	**C6.1**	**C6.2**	**C6.3**	**C6.4**	**C6.5**	**C6.6**	**C6.7**	**C6.8**	**C6.9**			
Period 1	64	95	90	74	3	43	17	18	26			
Period 2	59	95	132	66	10	30	18	47	38			
Period 3	51	48	83	29	16	15	9	30	18			
Category 7 - Humour												
Week	**C7.1**	**C7.2**	**C7.3**	**C7.4**								
Period 1	63	40	3	0								
Period 2	64	83	6	5								
Period 3	26	20	3	0								
Category 8 - Graphical Expressions												
Week	**C8.1**	**C8.2**	**C8.3**	**C8.4**	**C8.5**	**C8.6**	**C8.7**					
Period 1	167	5	1	0	43	21	2					
Period 2	290	23	12	0	94	23	7					
Period 3	91	12	0	0	34	11	3					
Category 9 - Ideas												
Week	**C9.1**	**C9.2**	**C9.3**	**C9.4**	**C9.5**	**C9.6**	**C9.7**					
Period 1	94	6	71	71	10	40	0					
Period 2	117	9	179	114	14	46	0					
Period 3	28	0	31	31	4	7	0					
Category 10 - Identification												
Week	**C10.1**	**C10.2**	**C10.3**									
Period 1	1	5	2									
Period 2	0	6	0									
Period 3	0	3	0									
Category 11 - Task/Work Specific												
Week	**C11.1**	**C11.2**	**C11.3**	**C11.4**	**C11.5**	**C11.6**	**C11.7**	**C11.8**	**C11.9**	**C11.10**	**C11.11**	**C11.12**
Period 1	1	1	0	0	0	0	0	0	0	0	2	0
Period 2	27	6	1	5	7	6	14	44	20	1	9	14
Period 3	19	6	4	0	2	1	2	16	26	5	5	10
Category 12 - Goals												
Week	**C12.1**	**C12.2**										
Period 1	4	2										
Period 2	9	2										
Period 3	2	0										

Team L4 Sub-Categories Over Time

Category 1 - Planning work

Week	C1.1	C1.2	C1.3	C1.4	C1.5	C1.6	C1.7	C1.8	C1.9	C1.10	C1.11
Period 1	0	13	11	8	1	0	7	0	14	0	3
Period 2	1	15	78	42	8	8	10	3	11	14	18
Period 3	2	14	15	32	0	5	13	2	11	27	19

Category 2 - Planning admin

Week	C2.1	C2.2	C2.3	C2.4	C2.5	C2.6	C2.7	C2.8	C2.9	C2.10
Period 1	27	14	3	10	3	1	1	0	11	1
Period 2	62	12	15	21	9	8	9	1	69	7
Period 3	54	26	11	26	3	5	3	1	72	5

Category 3 - Decisions

Week	C3.1	C3.2	C3.3	C3.4	C3.5	C3.6
Period 1	0	1	3	4	0	1
Period 2	2	0	8	6	1	2
Period 3	1	0	3	7	1	2

Category 4 - Roles

Week	C4.1	C4.2	C4.3	C4.4	C4.5	C4.6	C4.7	C4.8	C4.9	C4.10
Period 1	2	0	0	0	2	4	7	1	16	5
Period 2	3	0	1	3	20	6	13	0	71	3
Period 3	7	3	0	1	29	8	9	2	90	14

Category 5 - Conflict

Week	C5.1	C5.2	C5.3	C5.4	C5.5	C5.6	C5.7	C5.8	C5.9	C5.10
Period 1	3	5	0	0	0	0	0	0	1	0
Period 2	26	6	0	0	1	0	3	4	0	0
Period 3	45	7	1	8	1	0	5	21	7	1

Category 6 - Social/Get to Know

Week	C6.1	C6.2	C6.3	C6.4	C6.5	C6.6	C6.7	C6.8	C6.9
Period 1	13	13	49	6	0	14	5	6	9
Period 2	33	30	108	15	7	22	8	23	17
Period 3	88	135	148	95	31	107	9	70	31

Category 7 - Humour

Week	C7.1	C7.2	C7.3	C7.4
Period 1	1	0	0	0
Period 2	10	8	1	0
Period 3	23	20	1	4

Category 8 - Graphical Expressions

Week	C8.1	C8.2	C8.3	C8.4	C8.5	C8.6	C8.7
Period 1	2	0	0	0	0	0	1
Period 2	27	4	0	0	3	3	1
Period 3	124	11	0	0	16	5	5

Category 9 - Ideas

Week	C9.1	C9.2	C9.3	C9.4	C9.5	C9.6	C9.7
Period 1	36	3	43	30	2	11	2
Period 2	74	0	157	85	11	38	1
Period 3	121	1	249	158	4	24	1

Category 10 - Identification

Week	C10.1	C10.2	C10.3
Period 1	1	11	2
Period 2	3	7	2
Period 3	6	10	2

Category 11 - Task/Work Specific

Week	C11.1	C11.2	C11.3	C11.4	C11.5	C11.6	C11.7	C11.8	C11.9	C11.10	C11.11	C11.12
Period 1	0	0	0	0	0	0	0	0	1	0	2	1
Period 2	37	4	5	2	5	8	22	22	41	3	7	16
Period 3	51	9	19	6	15	4	47	76	145	14	33	46

Category 12 - Goals

Week	C12.1	C12.2
Period 1	1	0
Period 2	0	3
Period 3	10	12